



# The American Journal of Surgery

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NEW SERIES, VOLUME LXXVI

JULY TO DECEMBER

1948

PUBLISHED MONTHLY BY

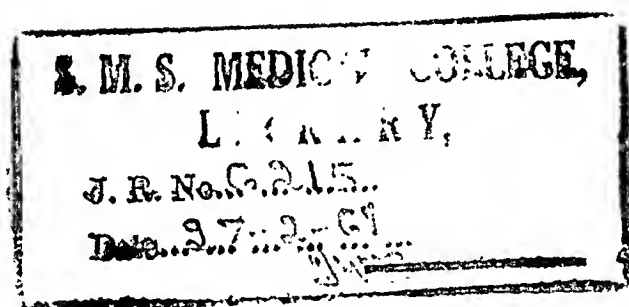
THE YORKE PUBLISHING COMPANY, INC.

49 WEST 45TH STREET, NEW YORK 19, N. Y.

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# The American Journal of Surgery

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A PRACTICAL JOURNAL BUILT ON MERIT

Fifty-seventh Year of Publication

VOL. LXXVI

JULY, 1948

NUMBER ONE

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## Editorial

### RADICAL PALLIATIVE SURGERY IN CANCER

SINCE the early days of the healing art, it has been recognized that if cure is impossible or improbable, it is the duty of the doctor to do what he can to relieve the suffering of the patient. In surgical practice such efforts are referred to as palliative operations. It is worth calling attention to a trend of the last few years toward a more definitive and humane type of palliative surgery.

It has not been long since palliative abdominal surgical procedures consisted principally of the "ostomies." Gastrostomy was used to add a few miserable months, utterly without hope, to the life of the patient with esophageal cancer. Gastrojejunostomy was chosen for the patient who was starving because of carcinoma of the pyloric end of the stomach; the short-circuiting operation was used instead of resection because of the presence of liver metastases or extensive glandular involvement. The individual still faced a certain if somewhat slower death and he was sick from the effects of the large primary tumor deliberately left *in situ*. Colostomy has often been made proximal to a tumor of the large bowel, the mass itself being left undisturbed because of the presence of hepatic metastases.

Now, the cancer surgeon will resect many of these malignant growths along with their macroscopic metastases and will use con-

siderable ingenuity to restore the functional continuity of the involved parts. Carcinoma of the esophagus is treated by excision of the tumor and anastomosis of the remnant of esophagus to the fundus of the mobilized stomach, even if the suture line is of necessity placed in the apex of the chest. Malignant tumors of the stomach and colon would be removed along with their regional metastases even though the liver and other contiguous organs have been invaded.

These more satisfying procedures in patients with advanced carcinoma are possible because of improvements in the care of patients before, during and after large operations. A number of surgeons have done yeoman service in pushing ahead the frontiers of operability to an undreamed of extent. Notable among these is Brunschwig, whose recent monograph contains the histories of 100 cases of advanced abdominal cancer treated by radical surgery. True, there was an operative mortality of 34 per cent and 17 per cent received no palliation. No apology is indicated; there was all to gain and nothing to lose. And much was gained with one-half of the patients. Thirty per cent received appreciable palliation while 19 per cent had a prolonged survival time. Six per cent lived on for an average of three years, finally succumbing to cancer. Thirteen patients



were living after more than three years with no detectable evidence of malignant disease. Similar but small reports have been made by Saltzstein and his co-workers, Howes and Shapiro and others.

The field of applicability of newer radical surgery is not confined to the gastrointestinal tract. Piekrell and his group have recently called attention to the fact that recurrent carcinoma of the breast should not be considered inoperable until the possibilities of resection of a portion of all layers of the chest wall have received attention. For example, they removed an area of recurrent malignancy involving the sternum and cartilages over the heart. The underlying fibrous pericardium was used to provide a relatively stable chest wall and the cutaneous defect was closed by a split-thickness graft applied directly to the pericardium!

The thoracic surgeon will find oppor-

tunities to exert himself in the direction of removing "inoperable" tumors. Masses of involved mediastinal lymph nodes many times larger than the primary bronchogenic lesion have been removed along with the lung to result in a surprisingly prolonged survival time. One hears of instances in which one or two foci of pulmonary metastasis have been removed by lobectomy with the patients living year after year without evidence that their bodies harbor any other malignant cells.

Such procedures take time, patience, better than average surgical skill, good anesthesia and what is probably most important, large quantities of blood for replacement. The reward of the effort is that an operation which was modestly considered only palliative at first may possibly produce a permanent cure.

CONRAD R. LAM, M.D.



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# Original Articles

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## FREE SKIN GRAFTING

JOHN A. JENNEY, M.D.

*New York, New York*

MANY articles by various authors have appeared in the literature on the subject of "Free Skin Grafting." Although they all vary somewhat in preoperative treatment, operative technic and postoperative care, all have been crowned with success. We believe this very success has been responsible for questionable theories about free skin grafting.

We are led to this conclusion if we recognize the "Law of Parsimony in Science," i.e., that the simplest explanation or interpretation which will account for all of the facts is the one to be preferred. In free skin grafting the simplest explanation of this success, compatible with the facts of universal success, is that each successful technic fundamentally performs exactly the same function of every other successful technic for immediate tissue growth. Perpetuation of this growth for the indefinite future is another matter.

The thought then arises that there must be certain fundamentals common to all technics which are responsible for all of the good end results; and that probably the various successful technics should be scrutinized from two standpoints, one as to their ability to aid these fundamentals and the other from the standpoint of not interfering with these fundamentals. Consequently, we believe that a re-investigation of free skin grafting is in order to find out what these fundamentals are, with the aim of possibly simplifying and standardizing technics. As to ourselves, we have continued to use the technic described in a previous article.

The scope of this paper will begin at the point where, in healed or unhealed wounds

of the integument, free skin grafting can be considered a form of treatment. What will be said is merely our interpretation of the original work of many others, anatomist, physiologist, pathologist and clinician, and an adaptation of their knowledge to fit our particular needs.

The essence of our interpretation of free skin grafting is physiologic, namely, that the body strives to heal by first intention and compromises on second intention healing. The essential difference between wounds healed by first intention and those healed by second intention is the difference between a small amount of scar and a large amount of scar. We attempt to control conditions as far as possible to obtain first intention healing.

At this point mention may be made of the accepted fact, that the best time to free skin graft is immediately after an operation or injury if conditions are favorable for this procedure. At this time, primary tissue (graft) may be placed in contact with primary tissue (host) with no secondary tissue intervening.

The technic we use is based upon our interpretation of rather broad theoretic concepts of the tissues in which we are interested, coupled with factual anatomic and physiologic characteristics of those tissues. These will be briefly discussed.

The animal body is developed from three embryonic layers, the ectodermal, mesodermal and endodermal. Skin is developed from two of these layers: the epidermis (ectodermal epithelium) from the ectodermal layer, and the dermis from the mesodermal layer. Hair, nails, sudoriferous

glands and sebaceous glands are derived from the embryonic ectodermal layer.

Epithelium, the tissue which covers all free surfaces of the body, is derived from all three embryonic layers. It consists of compactly packed cells with little intercellular substance between them. The intercellular substance which holds the cells tightly together is in the form of intercellular cement bridges which extend from one cell to another. In the clefts around the bridges tissue fluid is found. Although the cells at one time are surrounded by tissue fluid, arrangements are made in the various types of epithelium to prevent loss of body fluid as occasion demands. An example of this is found in the epidermis where there is a gradual transition from the wet cells of the innermost layers to the completely dry cells of the outermost layer. Essentially, epithelium is water-tight.

Fundamentally, we are bags of epithelium filled with liquid which contains a pump-cardiac tissue. The epithelial bag keeps us wet animals; the cardiac tissues circulate this wetness. If this bag ruptures causing loss of vital liquid or if the pump falters in circulating this vital liquid, disastrous consequences result. Within the walls of this bag of epithelium every ailment of mankind is taken care of. Regardless of the nature of the injury to the body, repair cannot go along well unless there is a high degree of efficiency in the epithelial and cardiac tissues.

As a working hypothesis, we prefer to believe that the various degenerative processes which sometime follow extensive wounds of the integument are due not only to passive destructive effects, caused by loss of all of the essential elements found in vital fluid, but also to an active physiologic policy of starvation of less important tissues to keep more important tissues in a state of health.

Since we have an excess of tissue in our organs and a large functional reserve, two kidneys, two adrenals, abundant muscle, etc., a general balanced plan of starvation of this excess tissue to the point of com-

plete cessation of its functional activities (with an attending type of atrophy from disuse) would still allow normal body function, but the general plane of body efficiency would be lowered. This parasitic struggle of one tissue complex to survive at the expense of another tissue complex would result in degenerative processes which, in a sense, could be considered physiologic amputations. If this parasitic struggle continues, a minimum plane of general body efficiency will be reached, resulting in general body dissolution. Depending upon the organic status of different individuals, maintenance of this balance would necessitate hyperactivity of certain organs. This could be followed by atrophy from overuse. In such cases atrophy from disuse and atrophy from overuse would be going on at the same time. To break this ever expanding circle of self-destruction, we must either substitute for vital fluid loss or prevent vital fluid loss by free skin grafting. The former is difficult; the latter is easy. These thoughts are translated into a very important practical fact in our technic of free skin grafting and will be discussed later.

Barring specific disease, we know epithelial and cardiac tissues will survive at the expense of all other tissues; their vitality is tremendous. This conclusion is reached by observing disease in general and chronic wasting disease more specifically. In chronic wasting disease in which normal metabolism and normal resistance is at a low ebb, it is more necessary than ever to protect the body and keep the flow of body fluids going until the last remote chance of body repair has failed. While both of these tissues are affected adversely in such cases as far as the epithelium of the skin is concerned, only a minimum amount of care is needed to keep it intact. It will live at the expense of the body in order to protect the body and function for body needs.

Nourishment for this specially designed tissue is found universally in the body. Epidermis has no direct blood supply; it lives on tissue fluid.

Tissue fluid circulation is sometimes called the fourth circulation. Since every cell in the body is bathed by some form of tissue fluid, it follows that epidermis could survive in almost any location in the body. We know that it will grow on fat, bone, granulation tissue, muscle and, if the occasion ever arose, would probably grow on brain, liver, kidney or any other tissue. Its ability to grow on bone is a valuable asset to the otologist who so frequently skin grafts mastoid cavities. Specifically, the technic developed by Dr. Joseph B. Kelly\* demonstrates that free skin grafts will take successfully in radical mastoid cavities when they are properly applied. Its importance to the surgeon because of its ability to grow on bone allows him to clean up a dirty area quickly while other operative procedures are contemplated or are in the process of development.

Surgically speaking, only two requisities are necessary for the growth of transplanted epidermis: (1) a surgically sterile, dry bed for immediate epidermal growth and (2) everflowing springs of tissue fluid for its continued existence.

Some authorities state that skin has more functions than the liver. This thought would lead one to believe that the outer portion of such a complex organ must be very delicate. This is not the case. Epidermis is a very tough tissue and will prepare its own living conditions if given a fighting chance. We believe that too little reliance is placed on the ability of the epidermis to take care of itself. It has learned to take care of itself by fighting through the ages of its development, harmful influences both from without and from within and has well solved its problems of survival. Recognition of this fact is of great importance to us. For this reason alone, we commonly and without hesitation allow many of our free skin grafts to go undraped and open to the air immediately after a free skin grafting operation. Also recognition of

this fact will curtail overzealous treatment which is one reason we believe that accounts for disappointing results at times.

The inherent quality of this resistant tissue to live at the expense of the body has a great bearing on the question as to the time to do a skin grafting operation. The time for free skin grafting is when the patient can tolerate a minor operation. In other words, our concern is with the patient only and his ability to withstand an operation; we are not concerned with the epidermis and its nutrition. The epidermis is well able to take care of itself if applied to the recipient area properly. We believe that for this reason, establishing a certain minimum of body economy, or trying to establish a certain blood level as to hemoglobin or red cell count, leads to needless delay in free skin grafting. The continual loss of vital fluid incident to delay might be reflected throughout the body in degenerative processes of vital organs, as before indicated. The plane of body efficiency is lowered and the patient presents the picture of starvation. A few small grafts here and there on an ill patient means just so much plugging up of open drainage areas. These will increase in size, body fluids will be conserved and body economy will improve. Early skin grafting is important especially in regions of the small joints, such as the hand. If delayed, surgical complexities may develop which cannot be solved.

*Epidermis.* There are gradual changes in the anatomic configuration of the epithelial cells in the epidermis from within outward. Collections of cells undergoing change which have many features in common have been grouped for descriptive purposes into strata. These strata from within outward have been named, stratum basalis, stratum spinosum, stratum granulosum, stratum lucidum and stratum corneum. The stratum basalis and stratum spinosum together are called the stratum germinativum. It is in this stratum that cell multiplication takes place. The closely packed arrangement of the cells in the stratum basalis, together with the tight

\*Director of Manhattan Eye, Ear and Throat Hospital.

interlacement of the projections of the cells in the stratum spinosum, prevents the loss of body fluid by seepage. When skin is damaged down to, into or through this combined layer, seepage of tissue fluid results.

thin felt-work of fine fibrous tissue bundles. This is the portion of dermis through which tissue fluid flows to nourish the epidermis. Controlling conditions in order to help nature reconstruct this all important zone is our sole aim in free skin grafting.

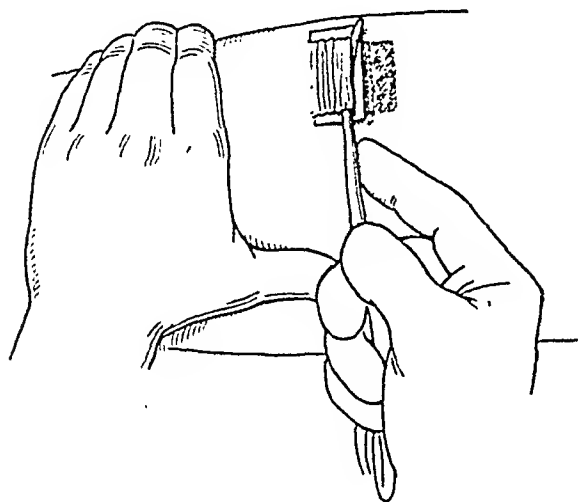


FIG. 1. Cutting a split thickness graft; in this instance with a safety razor blade.

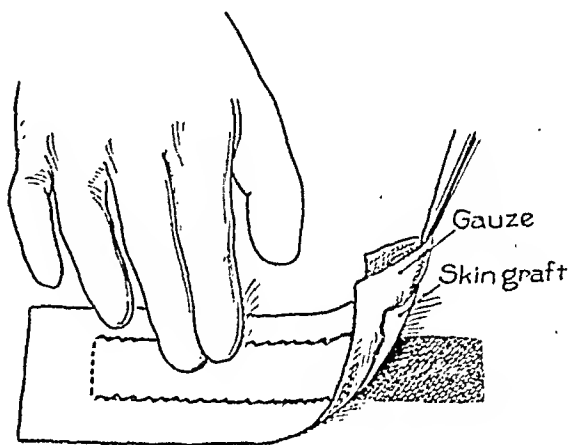


FIG. 2. "Backing" applied to graft.

**Dermis.** The dermis consists of blood vessels, lymph vessels, fat, yellow and white connective tissue and nerves. Hair follicles, sebaceous glands and sudoriferous glands found in the layer of dermis are derivatives of and down shoots from the epidermis. The dermis begins at the basement membrane of the epidermis and gradually merges without any definite line of demarcation with the subcutaneous tissue. The superficial portion of the dermis is called the pars papillaris, the deeper portion is the pars reticularis. The yellow connective tissue fibers found in the dermis are called the elastic fibers. They are numerous in the young and relatively few in the aged which accounts for the shrinkage of a free skin graft from 40 to 50 per cent in the young and no more than 10 to 15 per cent in the aged. Physically, the dermis holds the epidermis to the body; physiologically, it supplies nourishment to the epidermis.

Between the basement membrane of the epidermis and the layer of dermis is a

The broad concepts of our interpretation of important factors involved in free skin grafting have been discussed up to now. Other important points to be considered will be discussed under the separate headings of what we consider to be the four cardinal factors of free skin grafting, namely, surgical technic, rôle of the blood clot, rôle of secondary tissue and finally postoperative care or the rôle of protection of the graft after operation.

#### SURGICAL TECHNIC

We realize and submit to the fact that if we are dealing with a wound covered with granulation tissue, we are dealing with a badly infected wound; that is, the healthy granulations are covered with myriads of bacteria of many varieties. Our interest in the kinds of bacteria present is purely academic. We are convinced that we cannot sterilize the tissue by any means other than by its almost total destruction by a corrosive agent; so we destroy it. How-

ever, we seldom use granulation tissue in free skin grafting, so its total loss is of no moment to us.

Granulation tissue and bacteria are destroyed by sweeping a lunar caustic pencil back and forth across the bed of

firm collagenous tissue between the primary tissues of the body and the outside world. The picture of the colored boy\* demonstrates the method of removal of the secondary tissues. The yellow layer of tissue, which is seen in the pictures after

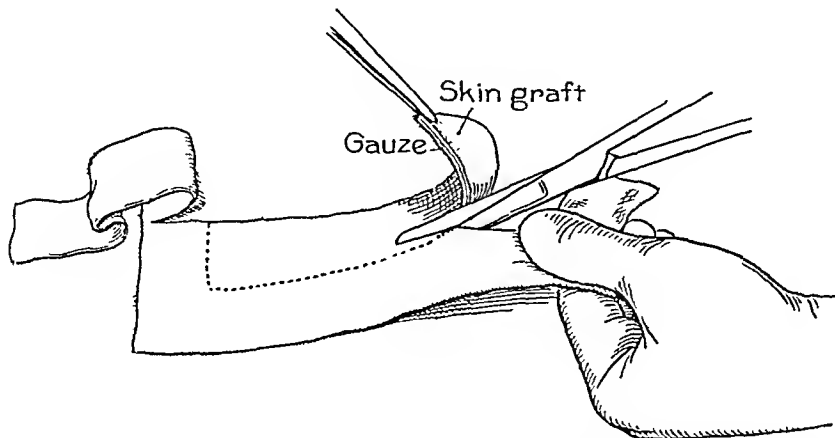


FIG. 3. Cutting the graft and backing as one piece. Frayed edges of the graft are cut off in order to have straight edges.

granulations and a muddy gray, silver nitrate impregnated slough is produced. Normal saline is poured over the area and the color immediately changes from grey to white. The silver nitrate is changed to insoluble silver chloride. The borders of the

removal of the secondary tissues, is fat as it appears through a thin layer of collagenous tissue.

Dry bandages are immediately applied over the bleeding area. These bandages are not changed but are lifted at intervals.

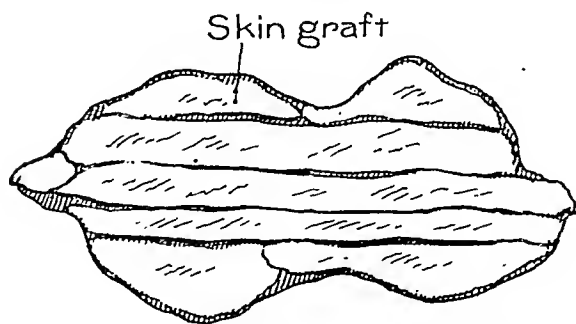


FIG. 4. "Backed" grafts applied to recipient area. They may be cut in various shapes; overlapping is not harmful.

white area are then incised down to the plane of demarcation between normal and secondary tissue. By means of a scalpel held at about 45 degrees, the collagenous tissues, with their tuft of remnants of granulation tissue, are "slid" off. A very smooth floor of freely bleeding capillaries is produced. They are in the smooth plane of

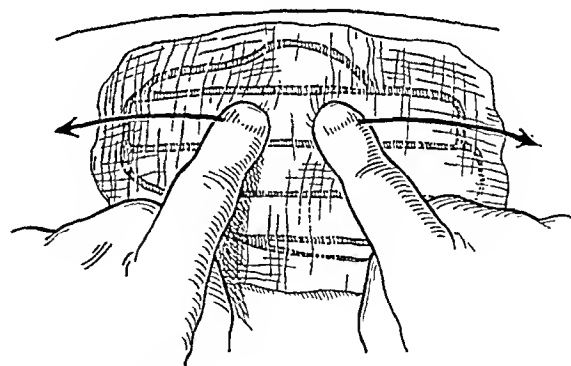


FIG. 5. "Fixing" the grafts by massage. Massage is continued until there is a "fixed feel" to the grafts. A single layer of backing is placed over the "backed" grafts to prevent dislocation of the grafts and also allow the escape of excess fluid.

They almost immediately become soaked with blood. Pressure is maintained over

\* Plate 2. In JENNY, JOHN A. A modification of the plasma fixation method (Sano) of skin grafting by the use of bobbinet and a mirror attachment. *Am. J. Surg.*, 67: 3-7, 1945.

them. Within a minute or so the blood-soaked bandages are lifted or twisted over the wound and pressure is again applied. This is repeated a few times, the object being to loosen the bandages from clotted

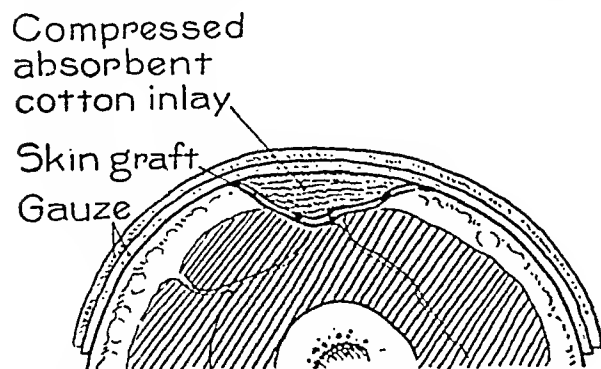


FIG. 6. Damp absorbent cotton inlay to insure close apposition of the graft to uneven surfaces.

areas which have ceased to bleed and to continue pressure over areas which are still bleeding. Within four to five minutes (the normal time for clotting of blood) all bleeding will usually have stopped. Since all of this bleeding has been of the capillary

"fixed" to the host by a thin layer of physiological glue, the clot. At this stage the operation is completed. Nothing further has to be done except to decide upon some method of protection of the graft for

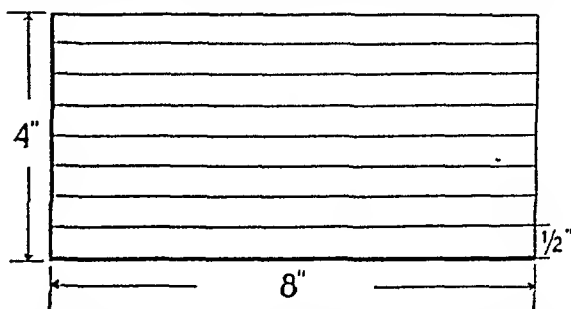


FIG. 7. "Continuous epithelization" when epithelial coverage and not epithelial thickness is important. A 4 inch by 8 inch piece of skin is cut lengthwise into  $8\frac{1}{2}$  inch pieces. Discounting the width dimensions, each piece will have a growing edge of 16 inches. In this instance the growing edge is increased from 16 inches to 128 inches.

the future. This phase is considered under "Postoperative Care."

Difficulties in the handling of free skin grafts can be eliminated largely by "back-

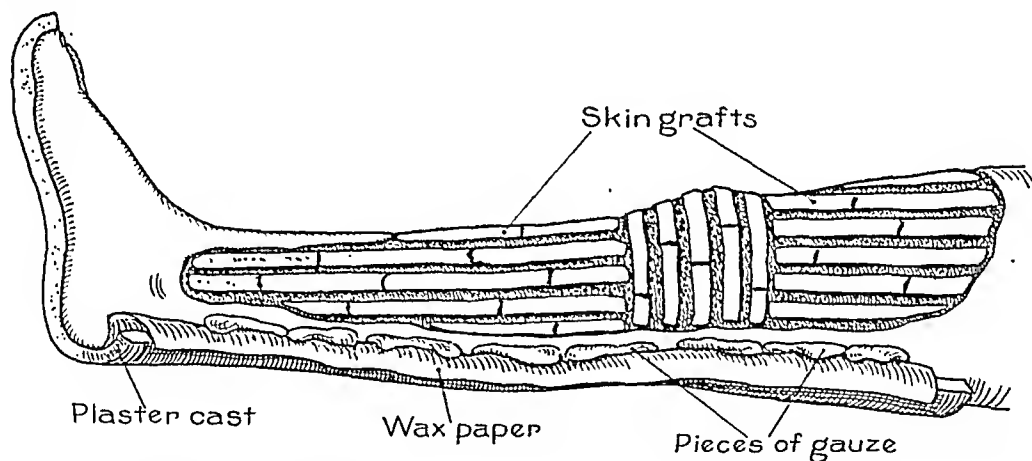


FIG. 8. "Continuous epithelization" under a cradle with no bandages over either the grafts or granulation tissues. The wax paper is changed by elevating the part. Gauze in the "trough" to absorb secretions are changed without disturbing the paper.

type, it is rare that a suture is ever needed to control bleeding.

Grafts are then applied over the dry recipient area (dry in the sense of oozing; it may be necessary to sprinkle with blood) and are massaged until a "fixed feel" is present. At this time the graft is tightly

ing" the grafts either at the time of cutting or immediately after. A method we use for "backing" free skin grafts at the time of cutting has been described in a previous article. The method we use for "backing" a free skin graft after cutting, using vaselized, broad mesh gauze or vase-

linized bobbinet, is illustrated. (Figs. 1 to 10.)

The method of free skin grafting we use depends primarily upon the amount and site of damaged tissue involved, and secondarily upon the cosmetic result. When

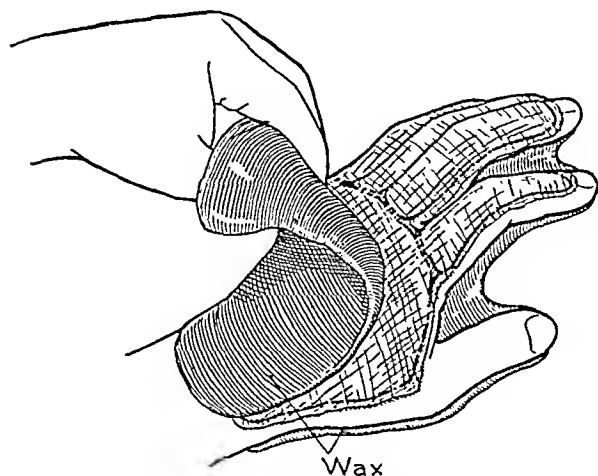


FIG. 9. Method of applying dental wax. The wax is applied directly on the "backing" of the grafts with no bandages intervening.

are not affected much and are well suited for removal of more skin at a later date.

Large Padgett dermatome grafts are used to cover smaller isolated areas and overexposed surfaces where a better cosmetic result is desired. Females are usually

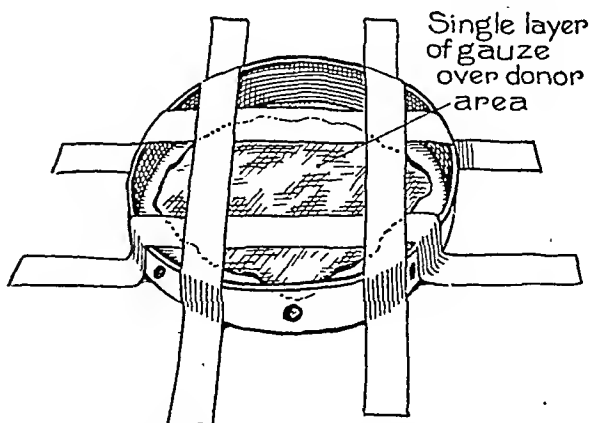


FIG. 10. Cardboard cup to protect the donor site. The cardboard is "faced" with tape to shape it. The same tape is crossed over it to allow circulation of air and to hold the cup in place. A single layer of dry gauze is placed over the donor site.

the area to be grafted is very large, we use the technic of "continuous epithelization"\* to cover the area. Skin is cut into strips and patches and spaced at intervals over the recipient area. The object is to increase the growing edge of the patch of tissue which has been removed. As one stage operation follows another in the advance over large areas or over multiple smaller areas, a tremendous growing edge of epithelium is established. Raw areas are gradually covered in the intervals from stage to stage. We are not at all concerned with the thickness of the grafts when covering large areas, rather we are concerned with the thinness of the grafts. We are concerned only with coverage, not thickness. The grafts will gradually thicken anyway because cells of the stratum germinativum, the strata of cell multiplication, are present in the grafts. Also if the grafts are cut thin enough, donor sites

treated with large sections of free graft such as those cut with the Padgett dermatome.

The donor site has only a single layer of gauze for a dressing. The area is then left exposed to the air. A clotting agent which has been used in the operation is usually sprinkled over the gauze to make a tight clot. If the patient is bed-ridden, only a cradle is used for protection. If ambulatory, a protecting cardboard shield covered with scotch tape is used. Our aim is to keep the area dry and, if dry, it will not become infected. We never use pressure dressings or water insoluble materials over the donor sites. If the shield bothers ambulatory patients, it may be removed after a few days; the rubbing of clothing over the dry crust causes no damage. The crust peels off after about ten days leaving a healed skin.

#### WHOLE BLOOD AND PLASMA CLOT

Probably the most important single factor involved in free skin grafting is the rôle of the blood clot. When blood clots, it changes from a liquid state to a firm

\* Plate 2. In JENNEY, JOHN A. A modification of the plasma fixation method (Sano) of skin grafting by the use of bobbinet and a mirror attachment. *Am. J. Surg.*, 67: 3-7, 1945.



glue, a physiologic glue called a clot, whose first function is to stick damaged tissues together. Success in free skin grafting is due to the internal fixation of the graft to the host by a thin layer of this glue. It is not due to external fixation of the graft to the host by bandages is an attempt to achieve the same result.

Depending upon this "fixative," the clot, we commonly do not put any bandages over our grafts, relying entirely upon splinting of the clot to keep the grafts in place. Photographs of two cases demonstrate this: one case a skin graft of a thigh and knee\* using large Padgett dermatome grafts, the other a skin graft of the hand,† using dermatome grafts. In neither case were external pressure bandages used. The grafts splinted by blood clot were "fixed" by massage. In the first, the extremity was immobilized in a fracture box without any bandages over the bobbinet. In the case of the hand, immobilization was obtained by splinting between two layers of dental impression wax. The red mass of impression wax can be seen in the palm; the wax over the dorsum of the hand has been removed. The wax is applied directly onto the bobbinet. This wax has many uses in plastic surgery. Among others, the use of hand splints was first seen by us as used by Dr. J. Eastman Sheehan.

Clotting of blood is an emergency measure; its first functions are purely mechanical. It binds, it covers, it protects and it supports injured tissues. The blood serum which does not clot and is squeezed out during the process of clotting probably provides instantaneous nourishment for damaged tissues, and "holds over" until the body has made other adjustments to feed adjacent tissues.

The mechanical functions of blood clot are precisely the same as the mechanical

functions of scar tissues, i.e., scar binds, covers, protects and supports injured tissues. Mechanically, the only difference between blood clot and scar tissue is that blood clot is structurally weak while scar tissue, white fibrous connective tissue, is structurally strong.

Taking these thoughts to the operating room, it would seem that if the graft has been firmly fixed to the host at the time of operation, it could be considered, theoretically, permanently healed to the host. Mechanically, the only changes which would take place in the future would be replacement of the mechanically weak clot by a mechanically strong white fibrous connective tissue. If then the graft is firmly fixed to the recipient area at the time of operation, it would seem that postoperative appliances should be used for protection only.

#### SECONDARY TISSUE

When a tissue is injured, endothelial cells from the cut ends of capillaries arrange themselves in rows and unite adjacent cut ends of other capillaries. These rows of cells connecting adjacent capillaries then become canalized and loops are formed. Collections of these loops which are red in color due to blood coursing through them are called granulation tissue.

Within four to five days after injury there is an invasion by myriads of fibroblasts within a wound. Their secretion (considered as such by some authorities) is named collagen. This soon begins to shrink, gets harder and gives strength to the wound. As the accumulation of collagen increases, the wound gets firmer, the capillaries are gradually strangulated and occluded and finally the permanent substitute for the injured tissue is formed which is scar.

To summarize the factors which concern us directly in free skin grafting: Granulations, as we see them in an open wound, consist of capillary loops in a menstrum of collagen surrounded by myriads of fibroblasts and covered with cellular debris,

\* Plate 3. In JENNEY, JOHN A. A modification of the plasma fixation method (Sano) of skin grafting by the use of bobbinet and a mirror attachment. *Am. J. Surg.*, 67: 30-7, 1945.

† Ibid. Plate 4.

coagulum, serum leukocytes and innumerable bacteria of many varieties. The thickness and firmness of the collagenous bed depends upon the age of the wound. In an early wound it is thin and soft; in a late wound it is thick and firm; in a wound healed by secondary intention hard scar serves as the substitute for the injured tissue.

Granulation tissue matures into only one type of tissue, white fibrous connective tissue, scar. It never changes its character; it never takes on the function of the cells in any organ in which it is found. It is seen, when we contemplate the changing histologic picture of repair tissue from its inception as granulation tissue through its various stages of capillary strangulation and then to its final mature state of hard avascular scar, that nature never intended repair tissue to support growth. Its function is to re-establish continuity of tissues, not to re-establish function of tissues.

When a tissue is injured, its metabolism often is lowered and specialized cells are adversely affected. Quite the opposite effect is noted in white fibrous connective tissue, an unspecialized tissue. It is a tissue whose metabolic requirements are lower than that of specialized tissue; and instead of the cells being damaged or killed in low metabolic areas, the contrary effect is noted, namely, cells increase in numbers in low metabolic areas. It seems illogical to graft epidermis on a bed of granulation tissue which has a thick base of collagen that will mature to avascular scar and expect it to function in a normal manner indefinitely. The metabolic requirements of skin are much higher than the metabolic requirements of white fibrous connective tissue. Why graft a tissue, which has higher metabolic requirements over a thick tissue of low metabolic requirements, which interposes itself on the major supply of necessary nutrition and expect it to grow when better conditions can be obtained? The fact that epithelium will grow on granulation tissue, which has a broad stratum of collagenous tissue beneath it, is no

argument for the benefits of secondary tissue as a nutrient media; rather it proves that epidermis is a very tough, vital, resistant tissue and will grow on almost anything. It is nourished by tissue fluid and even the sparse benefits it receives from sluggish springs of tissue fluid, as found in later stages of maturing scar, will allow it to survive after a fashion.

In view of the anatomic and physiologic facts of secondary tissue, we classify granulation tissue, in the category of free skin grafting, as useful, useless and pernicious: *useful* in the first stages of their development when the layer of collagenous tissue is minimal; *useless* at a later stage because a better base can be obtained if they are removed; *pernicious* still later because the healthy color of the firm, flat bed of granulation tissue belies the thick layer of strangling collagenous tissue beneath. The reason why they are firm and flat is because the collagenous tissue is at a late stage of maturity, the bed is strong and firm and the capillaries are partially occluded by organizing immature scar.

#### POSTOPERATIVE CARE

Starting with what we deem as fact, namely, that success in free skin grafting depends upon the adhesion of the graft to the recipient area by a thin layer of physiologic glue, or clot, our postoperative methods of treatment are broadly expanded. With the exception of accepted methods of supportive treatment, it may be summed up in one word, protection.

In instances in which general anesthesia is administered and when the grafts are not going to be covered, it is necessary to watch the patients closely until they have regained their senses; otherwise they may damage the grafts. Adult, ambulatory patients with uncovered grafts are told how to protect the grafts, and usually the patients can be relied on to follow instructions. Bed patients with uncovered grafts are put in a cradle to keep bed sheets off

the grafted area. All other patients are treated as necessity demands with some sort of an external appliance which may be bandages, vaseline gauze, adhesive plaster, medicated elastic bandages, Thomas splints, plaster of paris, fracture boxes, dental impression wax, etc.

Hand grafts are dressed routinely with dental impression wax. The wax is placed directly on the "backing" of the grafts with no bandages intervening between the wax and the "backing." The wax is softened in hot water, a mass of it is flattened with the hands and it is then laid on the hand in two slabs, front and back. Since the wax is soft when applied over the grafts, it will flow between the fingers and will fill all crevices. After one slab has been hardened with ice water (we usually put the palmar slab on first), the hand is turned and the other slab is laid on. This slab flows into all irregularities and will fit perfectly with the first slab. After this slab is hardened a gauze bandage is applied over the wax. The wax may be removed in slabs or may be cracked off.

We are not slaves to bandages. We commonly never use them at all; and when we do use them, they are never wet and bulky but are always dry or damp, rather small and well fitting. Uneven surfaces usually require bandaging since it is impossible manually to "fix" and sustain the graft to the host at the time of operation. In such cases absorbent cotton is made wet with normal saline and then is smashed almost dry to remove liquid. A thin, firm sheet of cotton results. This is cut to fit the contours of the wound, layer on layer from the base of the wound, and is carried to a little above the surface of the adjacent skin. A firm dry bandage is applied. This fixes the graft to all contours. Since the cotton is moistened before it is applied, it will never change its shape.

Pressure bandages should always be moistened and flattened before they are applied unless continuous elastic pressure is made over them. Dry bandages placed over a weeping wound immediately lose

their pressure effect as soon as they become moist.

We commonly do not put bandages over granulation tissue if bandaging them is inconvenient. The patient is much happier if the wound and himself, are kept dry and clean than he is when encased in wet sloppy dressings. Mineral oil over the granulations, peroxide occasionally to remove crusts and slough and dry gauze along dependent portions of the granulations to absorb secretions are all that is necessary. The gauze can be changed daily without disturbing the patient.

The common practice of always bandaging granulation tissue probably stems more from the psychic trauma produced by their "raw meat" appearance than from any logical reasons for the benefits of this method of treatment. Granulation tissue will drain until it has matured to scar tissue, bandages or no bandages. Heat loss can be easily solved with a light bulb. Wet dressings, unless they are kept warm, will dissipate body heat.

When bandaging granulation tissue, we usually use imbricated adhesive or heavily impregnated vaseline gauze covered with a firm, dry bandage. Adhesive plaster is the better of the two. When a dressing is changed, the adhesive at one end of the wound is lifted and the bandage is quickly and painlessly removed by sliding the scissors on the adhesive above the granulations the length of the wound. No bleeding is produced. Elastic adhesive over medicated gauze is used at times.

If wet dressings are used, they must be changed very frequently or unhappy events take place. Granulations will grow into the meshes of the gauze, and when the dressings are changed we have a shocked, screaming patient, a bloody field and, if the granulations are exuberant, dissecting hematomas. If the dressings are not changed frequently, there is bad odor, maceration of adjacent healthy skin and the patient is unhappy because of his wet unsanitary state. The fact that a soggy wet dressing answers all of the specifications for bacteria culture

(a perfect nutrient media, optimum temperature, a dark, damp environment) is of no moment to the granulations. They can flush off the bacteria with their secretions and thereby diminish the number of bacteria unless hampered by dressings which might and often do act as a dam.

#### SUMMARY

Our interpretation of fundamental factors involved in free skin grafting have been presented with the aim of extending the usefulness of this simple operative procedure. These fundamental factors involve theoretic and factual considerations of epithelial and secondary tissues.

The epithelial and cardiac tissues we believe are the most important fundamental tissues in the body; the epithelial tissues keep us wet animals, the cardiac tissues circulate this wetness. Barring specific disease, these tissues will survive at the expense of all other tissues in order to serve the body and work for body needs until the last remote chance of repair is gone.

We make use of the vital characteristics of the type of epithelium we are dealing with, the epidermis (ectodermal epithelium), in determining the time to operate, our operative procedure and postoperative care.

The time to perform a free skin graft operation is when the patient can withstand a simple operation; we are not concerned with the ability of the epidermis to survive. It will survive if applied to a suitable base properly and at the expense of the body if need be. Establishing a minimum of body economy as to blood count, hemoglobin, etc., leads to needless delay in free skin grafting. Loss of vital fluid incident to this delay causes degenerative processes in vital organs. The plane of body efficiency is lowered and the patient reverts to the picture of starvation.

We classify granulation tissue in the category of free skin grafting as *useful*, *useless* and *pernicious*. It is useful in the first stages of its appearance when the

collagenous tissue base is minimal; useless at a later date because a better base can be obtained if the granulation and collagenous tissues are removed; pernicious still later because the healthy appearance of the firm, flat granulations belie the thick layer of strangling collagenous tissue beneath. The reason why the granulations are firm and flat is because the collagenous tissue is at a late stage of maturity, the bed is strong and firm and the capillaries are partly occluded by organizing immature scar.

The epidermis has no direct blood supply. It lives on overflowing springs of tissue fluid. This fluid filters through a delicate white fibrous tissue feltwork of the dermis to the epidermis. Our operative procedure is designed to provide optimum conditions for the body to reconstruct from secondary tissue something similar to this fine feltwork which has been lost.

For this reason the firm, heavy blanket of secondary tissue found lying on the major supply of necessary nutrition is removed. This allows the body to reconstruct something of secondary tissue, more in keeping with the missing, delicate veil of primary tissue.

We believe that success in free skin grafting depends upon the internal fixation of the graft to the host by a physiologic glue, the clot. We do not believe that it depends upon the external pressure of bandages in an attempt to achieve the same result.

General, special, local and refrigeration anesthesia are used. As to thermal anesthesia, we follow the method suggested to Dr. Eastman Sheehan and ourselves by Dr. Frederick Allen, i. e., to apply ice bags continuously for two hours prior to operation over the donor site and the area to be skin grafted.

We have not been able to sterilize granulating areas surgically by any means other than by their total destruction with a corrosive agent. Since we do not use granulation tissue for skin grafting, its loss is of no moment.

Donor sites are unbandaged except for a single layer of gauze which is placed over the wound.

Postoperative care, except for general supportive measures, is confined to means of protecting the grafts. A variety of methods may be used.

Among those to whom we are personally indebted for their kindness and co-operation are Dr. J. Eastman Sheehan, Attending Plastic and Reconstructive Surgeon, New York Polyclinic and St. Clare's Hospitals, whose pioneering work and enthusiasm in the field of plastic surgery has been a constant source of stimulation to us, Dr. J. Edgar Burke, Surgical Director, Jersey City Medical Center, Dr. R. E. Brennan, Surgical Director, New York Polyclinic Hospital, Dr. J. J. Lavalle, Attending Surgeon, St. John's Hospital, Long Island City, Dr. J. J. Morrissey, Assistant Attending Surgeon, St. John's Hospital, Long Island City.

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# FILARIAL FUNICULITIS\*

## REPORT OF A CASE DISCOVERED AT OPERATION FOR INGUINAL HERNIA

BRADLEY L. COLEY, M.D. AND BENJAMIN LEWIS, M.D.

*New York, New York*

THE observation of a striking obstructive lymphangiectasis of both spermatic cords during an elective herniorrhaphy led to the disclosure of filarial funiculitis and prompted the authors to report this case and to consider the disease as it may be encountered in the United States.

Eve and McCarthy (1899)<sup>1</sup> in England operated upon a man with bilateral filarial funiculitis and removed from the right spermatic cord, dilated and hypertrophied lymphatic vessels containing a milky fluid in which microfilariae were present. Lothrop and Pratt (1900)<sup>2</sup> in the United States operated for varicocele and found a mass of light colored, dilated and thickened lymph vessels containing milky fluid and extending the entire length of the spermatic cord; microfilariae were discovered post-operatively in the peripheral blood. Flynn (1903)<sup>3</sup> in Australia removed a filarial nodule from the lower end of the spermatic cord. Cunningham (1906)<sup>4</sup> in the United States performed a bilateral excision of enormously enlarged lymphatic masses containing chylous fluid which extended from the internal inguinal rings to the testes. His patient had a nineteen-year history of recurrent attacks of filariasis; a swollen scrotum was the only other stigma of the disease. Sorour (1929)<sup>5</sup> described chronic filarial funiculitis in an Egyptian peasant, consisting of painless or slightly tender nodular masses. Berg (1931)<sup>6</sup> reported a case of a Virgin Islander with filarial lymphatic varices of the groin who was admitted to Harlem Hospital in New York with a diagnosis of bilateral inguinal and femoral hernia. Microfilariae were present in his blood and urine. Ray (1934)<sup>7</sup> ob-

served asymptomatic filarial lymphatic varices of the funiculus in India. Filariasis of the spermatic cord and epididymis and associated hydrocele were noted by Ferrer (1934)<sup>8</sup> in Puerto Rico. Kau (1936)<sup>9</sup> in India reported four cases of filarial funiculitis manifested by nodular masses in the scrotal portion of the spermatic cord. Two of the patients were asymptomatic and were discovered on routine physical examination. The other two presented themselves with painful scrotal contents. Two of the patients displayed microfilariae. In three, adult worms were found in the masses excised. Pasternack (1943)<sup>10</sup> reported two cases of filarial epididymo-funiculitis which were asymptomatic. One of them developed an acute episode on one side. Wolfe and Schofield (1946)<sup>11</sup> in England removed an adult worm from a dilated and varicose funicular lymphatic.

### TRANSMISSION OF FILARIASIS

The causative agent of filariasis is a nematode worm of the super family Filarioidea. The scientific name of the most important of these parasites is *Wuchereria bancrofti*. The disease it produces is referred to as Bancroftian filariasis. Filariasis is indigenous throughout practically all the warm regions of the world, including the United States.

The life cycle of *Wuchereria bancrofti* requires an asexual developmental stage in a blood sucking insect host and a sexual stage in man. A large number of mosquitos have been incriminated as the insect vector. Embryo filariae (microfilariae) are sucked up with blood when the mosquito bites an infected human. The microfilariae undergo several morphologic changes in the

\* From The Hospital for Special Surgery, New York, N.Y.

thoracic muscles of the insect. Approximately ten to twenty-four days after the microfilariae have been imbibed by the mosquito, the infective stage male and female larvae are ready for inoculation into a human host. The larvae enter and pass through the skin at the site of puncture made by the insect. They reach some part of the lymphatic system where they grow to full maturity. The biologic incubation period from inoculation until the worms are fully grown has been variously estimated to be between six and eighteen months after exposure. From time to time an acute inflammatory reaction occurs when the growing larvae temporarily block small lymphatic vessels or lodge in lymph nodes.

The adult parasites settle down in lymphoid tissue, generally in the vicinity of the groin, spermatic cord or epididymis, and produce inflammation and obstruction. There the males fertilize the females. The parturient female gives birth to enormous numbers of microfilariae which either remain in the lymphatic system or enter the blood to be sucked up by a mosquito. Microfilariae are non-pathogenic and non-infective to man and they remain viable in human tissues for a limited time.

#### CASE REPORT

The patient, a twenty-five year old Puerto Rican, was admitted to the Hospital for Special Surgery, June 17, 1946, with a chief complaint of progressive painless swelling of both groins following a strain from lifting, one month prior to admission. In his native land he drove a truck on a sugar plantation. He had always been in good health. He denied any history of chills, fever, severe headache, malaise, vomiting, recurring attacks of lymphangitis of the extremities and the spermatic cord, enlarged painful lymph nodes and erysipeloid rash. The patient was aware of elephantiasis in Puerto Rico but denied its existence in himself, his family and his native town. He came to the United States in October, 1944 since which time he had worked in New York City as a railroad laborer.

Physical examination at the time of admission was negative except for a bilateral indirect inguinal hernia, greater on the left than on the right side, and palpable painless inguinal, axillary and epitrochlear lymph nodes.

A Bassini-type bilateral inguinal herniorrhaphy was performed on June 18, 1946 by one of us. The left hernial sac measured 8 cm. in length, the right, 3 cm. Upon opening the hernial sacs an abnormal amount of thin yellowish peritoneal fluid welled out. Within the internal spermatic fascia, there was a mass of coiled tubular structures containing a milky fluid. They were prominent proximally at which point they disappeared into the internal inguinal ring; distally they tapered off to terminate at the tunica vaginalis testis. (Fig. 1.) Those on the left were more pronounced. These peculiar structures, which later were shown to be dilated lymph vessels, were loosely attached to the other cord structures. They collapsed and expanded on digital compression and were thick and rubbery on palpation. The tubular masses were dissected from the cord, clamped and ligated at the internal inguinal ring and at the tunica vaginalis testis and were excised.

Convalescence was uneventful. The patient was out of bed on the first postoperative day. The wounds healed per primam and the repair was firm on both sides at the time of discharge on June 28, 1946. Physical examination of the scrotal contents and the cords at discharge revealed additional disturbance. On the left the testis was normal but a very small hydrocele was present. A firm painless nodule, 1.5 cm. in diameter, was attached to the globus minor. Six non-tender beady nodules, located one above the other in the upper scrotal portion of the spermatic funiculus, were also found at this time. A cord-like structure, slightly smaller than the vas deferens, connected the chain of six nodules and continued beyond them proximally and distally. It is believed that this represented an obstructed lymphatic vessel undergoing hypertrophy and dilatation. On the right side the testis was normal but there was a firm, non-tender nodule, 1 cm. in diameter, connected with the globus major. Three beady non-tender nodules, anterior to the large nodule and lying on a horizontal plane lateral to the vas, were found just proximal to the upper pole of the tunica vaginalis testis. None of this pathologic condition was observed at admission

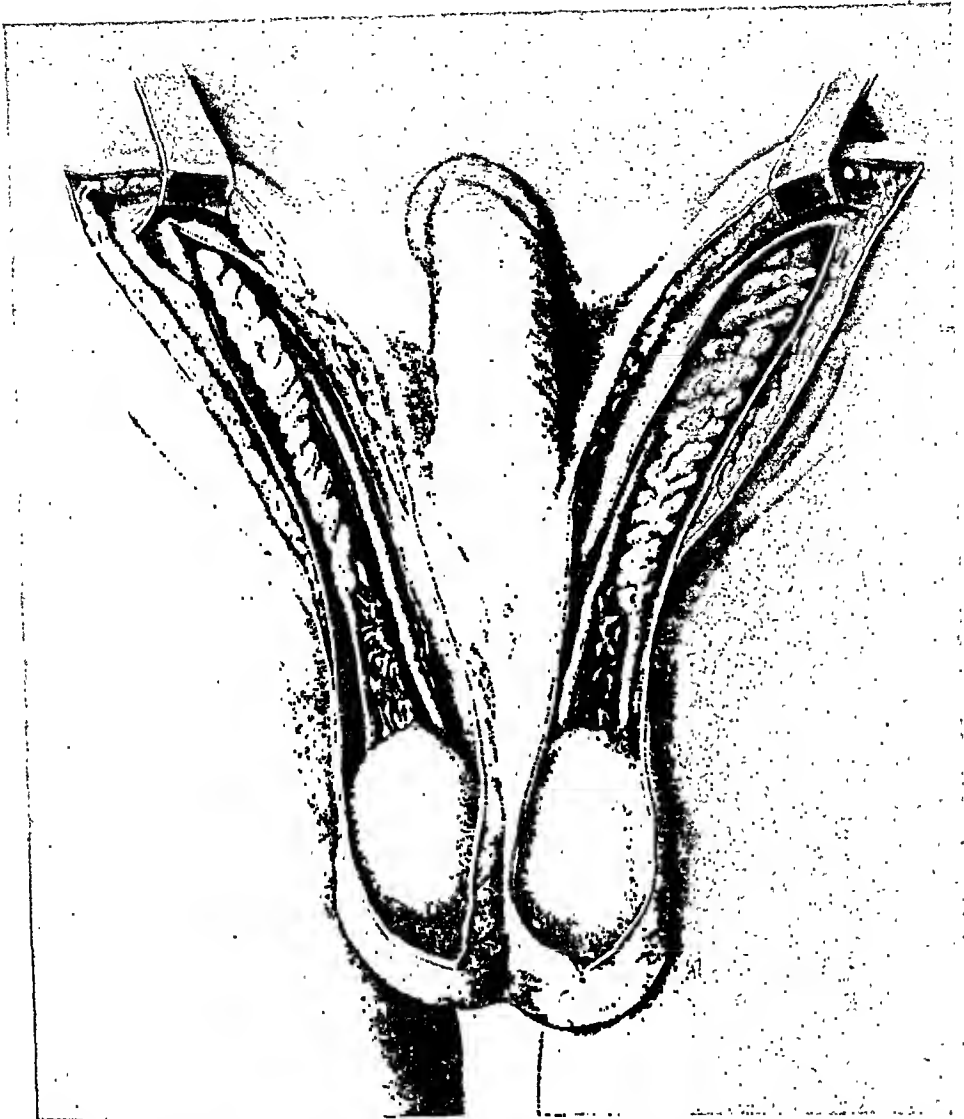


FIG. 1. Diagrammatic sketch of operative findings showing vas deferens, internal spermatic fascia, pampiniform plexus and hypertrophied and dilated lymphatic plexus.

nor at operation but it could readily have been overlooked.

A roentgenogram of the pelvis and the chest for calcified worms was negative.

Culture of the fluid in the lymph channels removed from the left spermatic cord was sterile. The nature of the underlying pathologic disorder being unsuspected at operation, examination of the lymphatic varices for adult worms was not made. *Microfilariae* of *Wuchereria bancrofti* were identified at the first blood study, the specimen being taken at 10 P.M. on June 22, 1946. The smear showed 31 per cent eosinophilia at the same time. A skin test with antigen of *Dirofilaria immitis* was not performed.

Dr. M. Helpert, the hospital pathologist, examined the excised specimens and reported as follows: "The specimen consists of two elongated tubular masses of tissue. The larger mass is 28 cm. long and from 5-15 mm. in diameter. The smaller mass is a similar structure 7 cm. in length and 5-15 mm. in diameter. (Fig. 2.) The surface is covered with areolar tissue. On dissection and cross section the tissues are seen to be made up of dilated vascular structures, evidently constituting a plexus of dilated and hypertrophied lymphatic vessels. The individual lymphatic components are from 2-5 mm. in diameter. Some of these have a cord-like consistency. On opening the largest of the vessels, the lumen is uneven in





FIG. 2. The plexus of lymphatic vessels excised from the left (A) and the right (B) spermatic cords, somewhat elongated due to handling.

caliber and the endothelial lining puckered and ridged. Microscopic examination of both specimens reveals thick walled lymphatic vessels with very large endothelial lined lumina. (Fig. 3.) The walls are composed of fibrous tissue thrown into ridges and folds. The interstitial connective tissue contains small congested blood vessels. The lumina of the dilated lymphatics do not contain any parasites. Diagnosis: Bilateral obstructive lymphangiectasis of the inguinal lymphatic plexuses."

Subsequent to discharge from the hospital, the peripheral blood of this patient was examined in August, September, October and November, 1946. Large numbers of microfilariae were found on all four occasions although the blood was studied at 2 P.M. each time. The hernia repairs remained firm and there was no change in the size of the hydrocele. Eosinophilia ranged from 16 to 26 per cent.



FIG. 3. Photomicrograph showing numerous lymphatic vessels, with extreme hypertrophy and dilatation ( $\times 16$ ).

#### CLINICAL PICTURE OF FILARIASIS

The clinical manifestations of filariasis vary greatly as would be expected in a disease which can take several decades in which to run its course. The important pathologic conditions associated with *Wuchereria bancrofti* infection result from involvement of the lymphatic system, consisting of inflammation, dilatation and rupture, hypertrophy, hyperplasia and fibrosis. The early and late stages of the disease are well known. The early stage received prominence during World War II following the observations of American medical officers in the Pacific.<sup>12</sup> The late stage is that of elephantiasis which, contrary to popular medical notion, is an infrequent end result of filarial infection. There remains a large intermediate group of cases which cannot be classified as early or late.

Early filariasis is the stage of acute and recurrent filarial infection following a period of exposure. The onset of symptoms has been reported as early as six weeks and as late as fourteen months after exposure. The manifestations of early filariasis vary with observers in different areas. Manifestations in the skin appear on the extremities as superficial lymphangitis, lymphadenitis and lymphedema. The lymphangitis is characteristically unusual in that it is centrifugal, extending distally from the site of a blocked lymphatic vessel. The inguinal, axillary and epitrochlear lymph nodes are enlarged during the attack, the latter nodes being said to be characteristic of early filariasis. Some observers have encountered lymphadenopathy in bizarre locations. Manifestations also occur in the deep lymphatics, and particularly so in those of the spermatic cord. The occurrence of funiculitis is a prominent finding by all observers. In addition, epididymitis, lymphangiectasis of the cord and hydrocele have been described both singly and in combination. Systemic manifestations, also known as mumu, wanganga, filarial fever and elephantoid fever, are of varying kind and degree. They consist of pyrexia, generalized aches and pains, malaise and urticarial rash. In some cases the deep seated lumbar lymphatic glands are involved. In such instances the systemic manifestations are present without evidence of superficial skin or genital involvement. Although unreported by the American observers in the Pacific, infection by streptococcus and staphylococcus superimposed upon the damaged lymphatics constitutes still another group of manifestations. It is common in endemic filarial areas where it is considered one of the factors in the progression of the disease to the more advanced stages. Bozicevich's<sup>13</sup> intradermal skin test with antigen prepared from *D. immitis* (dog-heart worm) appears to be diagnostic in about 80 per cent of cases. This is confirmed by Leede and Josey.<sup>23</sup>

Microfilariae are almost invariably absent from the peripheral blood. Eosinophilia is variable. Lymph node biopsies rarely disclose the filarial larvae.

In the presence of repeated reinfections with *Wuchereria bancrofti* and superimposed secondary infections, chronic lymphatic obstruction ensues and slowly progresses over a period of many years in about 5 per cent of cases of filariasis to elephantiasis of leg, scrotum, penis, arms, breasts, scalp, tongue, or vulvae. In 95 per cent of elephantiasis the lower extremities are affected. Microfilariae and eosinophilia are variable. The application of the Bozicevich skin test to this stage of the disease has not been reported in the literature.

The intermediary stage between early and late filariasis is characterized by the signs and symptoms of the early stage, particularly funiculitis and the almost invariable presence of microfilariae. Adenovarix, abscess, synovitis, chylous hydrocele, chylous diarrhea, chyluria, chylous ascites, lymph scrotum and adult worms have also been reported. Asymptomatic filarial funiculitis is not uncommon. As in our case and in others quoted earlier the stigmas of filariasis may be present although the patient may be unaware of their existence. In other instances all signs and symptoms may be absent but microfilariae will be found in the peripheral blood. In a survey of a large group of military age in the Virgin Islands, Brown<sup>26</sup> demonstrated 20 per cent with microfilariae, practically all of whom were unaware that they had filariasis. He believes that a large number of natives in endemic areas are infected in this manner. Anderson (quoted by Ferrer<sup>8</sup>) found microfilaria in 20 per cent of healthy natives in British Guiana who had never suffered with any signs or symptoms of filariasis. The occurrence of microfilaria, with or without recognizable pathologic conditions for long periods, is acknowledged by such authorities as O'Connor and Hulse,<sup>27</sup> Craig and Faust,<sup>28</sup> Manson-Bahr<sup>29</sup> and Strong.<sup>30</sup> Strong is of the opinion that

some of the asymptomatic filarial infections would develop symptoms if followed carefully for a period of years.

#### DIFFERENTIAL DIAGNOSIS OF FILARIAL FUNICULITIS

Filariasis of the cord is often associated with inguinal adenopathy and involvement of the scrotum, testicle and epididymis. These associated lesions may be sufficiently prominent to overshadow the funiculitis. Detailed points of differentiation for all the possible diseases of these regions will not be presented here. Proper diagnosis will depend upon the adequacy of physical examination and laboratory study.

Individuals with filarial funiculitis may be symptomless, or they may complain of a lump in the scrotum discovered accidentally or because of pain. A history of exposure in a filarial region can be elicited. Inguinal, axillary and epitrochlear lymphadenopathy, particularly the latter, and nodular masses in the spermatic cord or in the region of the epididymis are usually present. Of the greatest significance in the differentiation is the finding of a positive Bozicevich skin test, the presence of adult worms in the masses and microfilariae in the peripheral blood.

Diseases of the groin, spermatic cord, epididymis, testicle and scrotum must be distinguished from filarial funiculitis. Filariasis should be ruled out in every case of abnormalities in these structures: (1) Inguinal and femoral hernia, simple, irreducible or strangulated, can strongly resemble funiculitis of filarial origin. (2) The varicose pampiniform plexus of varicocele is palpable as a "bag of worms." They disappear in the supine position. Lymphangiectacele does not have the blue shininess of varicocele nor does it empty readily upon reclining. (3) Enlarged inguinal lymph glands arising from septic infection, from genital sores or from sores on the lower limbs, tuberculosis, syphilis, leukemia, Hodgkin's disease, lymphosarcoma and metastatic carcinoma or sarcoma can be confusing. (4) A hydrocele of the cord

tends to be cystic and tense. The upper and lower extremities are well defined. It does not disappear when the patient lies down. Hydrocele of the tunica vaginalis transmits light and can be primary or secondary to disease of the testis and epididymis. (5) Tuberculosis usually begins as a rounded, firm nodule in the epididymis of one side, frequently arising in the upper pole. The nodule is painless at first and may be found by accident, but as it enlarges it causes an aching pain. The vas deferens, seminal vesicle and testicle are involved by extension and additional nodules are formed. The tendency for caseation and sinus formation is very significant. Evidence of tuberculosis in other parts of the body can be observed. Skin tests may be of diagnostic aid in doubtful cases. (6) Lymphatic obstruction due to sepsis, chemical toxicity, venous thrombosis or congenital abnormality can simulate the lymphedema of filariasis. The enlarged scrotum and acute generalized edema of Bright's disease is seldom difficult to recognize. (7) The only common tumor of the spermatic cord is lipoma, frequently occurring with indirect inguinal hernia. It gives an impulse on coughing and is often mistaken for an omental hernia. Myxlipoma, fibrolipoma and sarcoma are of rare occurrence. Teratoma and other new growths in the testes lead to rapid swelling and tenderness extending proximally through the cord lymphatics. In such instances the cord condition is explained by the scrotal one. Fibrosarcoma of the scrotum is movable upon the testicle. (8) Epididymo-orchitis begins as a painful thickening of the epididymis associated with febrile symptoms. The vas deferens and tissues of the spermatic cord are thickened. All the structures become swollen, red and painful. The most common causes of epididymo-orchitis are gonorrheal urethritis and septic urethritis following trauma due to catheters, instruments, calculi and instillation of strong solutions. (9) Cysts of the epididymis cause swelling in the scrotum and an aching in the testicle

and groin. They may arise as retention cysts of the tubules of the epididymis or from the fetal remains, such as the organ of Giraldes, the hydatid of Morgagni and the vas aberrans of Haller. The spermatic cord is never involved. (10) The outstanding feature of syphilis is that it affects the body of the testis rather than the epididymis and tends to be bilateral. The cord and seminal vesicles remain normal. There is little pain when pressure is applied to the testicle. (11) An undescended testicle may give rise to pain or may be affected by diseases to which the normally placed organ is subject. Torsion of the testicle and malignant transformation are said to be more common than in the descended testicle. (12) Lesions other than those in the testicle can cause pain in that organ and might be of importance in differentiation. Calculus in the kidney, pelvis or ureter, carcinoma of the lumbar vertebrae and occasionally appendiceal inflammation cause testicular pain.

#### COMMENT

Our case was one of asymptomatic filarial funiculitis, accidentally discovered at operation for coexisting inguinal hernia. Our patient continued to display stigmas of filariasis, without resolution or progression of the lesions while remaining asymptomatic during a five month follow-up. It is unlikely that he will progress to elephantiasis since he has been removed from an endemic area and unsanitary environment, the two factors contributing to the development of the late stage. A specific treatment being unknown he will undoubtedly remain in the intermediate stage for a long time until the adult worms perish in the natural course of their existence and as a result of the pathologic changes they incite in the tissues they inhabit.

Filariasis merits a certain amount of importance today. American forces were exposed to the disease in several theaters of war. A number of them contracted the early stage of the disease and required hospitalization. It is certain that others

who were infected were not hospitalized. It is possible that the disease will progress in some of them, regardless of whether or not they displayed evidence of early filariasis. The same is more applicable to natives of Caribbean countries where filariasis is endemic, particularly Puerto Rico. These people have been attracted to the United States in recent years in large numbers by reason of favorable labor conditions. Cases of filarial funiculitis are certain to appear in the practice of the general surgeon, the genitourinary specialist and the general practitioner. For some years to come filariasis must be considered in every chronic swelling about the groin and the external genitalia occurring in anyone who has visited or lived in endemic areas. Only an awareness of this condition will obviate incorrect diagnosis and aimless treatment directed toward a number of conditions which resemble it. In these respects the recognition and management of filariasis in the office and at the operating table in unsuspected cases assume importance.

#### SUMMARY

1. A case of asymptomatic filarial funiculitis is presented.
2. An increase in the occurrence of filarial funiculitis in this country seems probable.

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# INTRAVENOUS DRIP ANESTHESIA WITH PENTOTHAL SODIUM

A REPORT OF 7,694 CASES

GEOFFREY COTTAM, M.D.

*Sioux Falls, South Dakota*

THE induction of sleep for the purpose of accomplishing certain therapeutic procedures painlessly has largely been done through the use of inhalation of vapors and gases. The most ideal anesthetic is the one that has the widest range of safety and the one that comes nearest to natural sleep without severe after effects. We believe that our experience in over 7,000 operations under intravenous pentothal sodium, alone and in combination, will throw some light on this form of anesthesia.<sup>1</sup>

The data for this paper come from a survey of the anesthetic and operative records of McKennan Hospital and Sioux Valley Hospital, both of which are located in Sioux Falls, S. D. The years surveyed are 1940 to 1946, inclusive, although we began to use pentothal cautiously when it first became available.

In looking over our statistics the reader may be surprised to note that 4,656 of the cases reported were major surgery patients and that these include nearly every type of general surgical procedure. The literature accompanying pentothal sodium solutions and various previous articles<sup>2-4</sup> warn against the use of this anesthetic for major surgery or prolonged procedures.

We began using pentothal for major operations and prolonged procedures, for the most part, purely by accident and circumstance. It came about quite naturally when some of our surgeons would schedule a minor operation that would turn out to be major, or a short operation that would become a long one. For instance, a surgeon would start what was to be a quick appendectomy and find that he must do a

bowel resection instead. Since the condition of the patient would seem satisfactory, the anesthetic would not be changed. After a few of these accidental uses of intravenous pentothal one prominent and gratifying result was noted, namely, the postoperative course was smoother than after any other anesthetic. There were fewer cases of vomiting and gas pains, and fewer instances of acute dilatation of the stomach. The recovery period was shorter. Quite by accident we learned another valuable piece of information. When one of our surgeons would begin an operation under pentothal and later switch to an inhalation anesthetic for better abdominal relaxation, we noted the postoperative recovery was much smoother than if we had used an inhalation anesthetic alone. As a result we began to use combination anesthetics.<sup>5-7</sup> These combinations would vary with the surgeon and the task at hand. Our most popular form of anesthetic today is a combination of intravenous pentothal sodium, oxygen, cyclopropane and curare. This combination constitutes about 45 per cent of all general anesthetics given in our two hospitals today.

We have never been unmindful of the warnings against the use of intravenous pentothal<sup>2,4,8-10</sup> and these warnings and dangers we wish to discuss thoroughly. We think the dangers previously reported were due to the improper administration of the anesthetic or to inexperience. We have developed a safe method of administration and, equally important, pre- and postoperative management. We have had no anesthetic deaths and our postoperative complications are less than ever before in

spite of the increased use of pentothal. The reader will recall that the main dangers of intravenous pentothal have been respiratory and vasomotor depression. A discussion of the evolution of our present method will show how improper administration produces these dangerous symptoms of respiratory and vasomotor depression and proper administration avoids them. Since the writer was on the anesthetic committee of McKennan Hospital for the year 1942, operative records were kept with particular reference to respiration, as to rate, amplitude and cyanosis. Also blood pressure readings were plotted on charts and postoperative complications were added to the anesthetic charts. The age incidence was eight to eighty-seven.<sup>11-13</sup>

*Evolution.* We made mistakes at first; we began with the usual preoperative orders of no breakfast, enemas and a preoperative hypodermic of morphine and atropine. We found that if the hypodermic was given too near the time of operation some respiratory depression was evident on induction. We avoided this by giving the preoperative hypodermic one hour before operation.

*Induction.* The psychologic effect on the patient who knows he is going to get intravenous anesthesia is noteworthy.<sup>12-14</sup> There is a lack of apprehension often shown because of fear of the smothering sensation under the mask of an inhalation anesthetic. We began, like everyone else, with a 5 per cent solution in a syringe. We noted an absence of vomiting in the first and second stages, but we were at a loss to account for frequent regurgitation of stomach contents into the pharynx. This we found was due to singultus and it is sometimes so mild it can hardly be detected. Nevertheless, it is so frequent with intravenous induction that we insist that the head of the table be lowered until the patient is asleep and we thereby prevent aspiration of stomach contents by gravity and pharyngeal suction. This is important. At first we had the patient count out loud until he could no longer count. This we found is unnecessary

and prevents a more rapid induction. The loss of the corneal reflex is a good guide that the patient is asleep.<sup>15</sup> In addition, the abdominal skin is pinched with tissue forceps in the line of the purposed incision. Loss of the pain reflex is an excellent sign that the incision can be made.

*Operation.* We were disturbed during the operation by the fact that the anesthetic was not an even one. The respirations would at times get shallow, the blood pressure would fall and at times slight cyanosis would appear. These symptoms would be evident every time the anesthetist would use another syringe full of anesthetic. On the other hand, if the intravenous injection was not given frequently, the patient would tend to come out of the anesthetic.<sup>16-17</sup> Frankly, it appeared that the anesthesia would be too deep one minute and too light the next. On conferring with our head anesthetist on this unevenness, she suggested that a more even anesthetic might be obtained in a continuous intravenous drip apparatus<sup>1, 18-19</sup> with a clamp on the tubing. We were delighted to find that this did away with the unevenness of the anesthetic and we promptly discarded the syringe and will not permit its use.

Another fact became of interest to us. Some patients slept for such long intervals afterward even when small amounts were given for short procedures. We decided to try weaker solutions and that definitely answered this problem. Now we never use a solution that is stronger than 1 per cent and in very young or very old people we frequently use  $\frac{1}{2}$  per cent. The average strength of the anesthetic used now in both hospitals is 1 per cent and the patients wake up promptly.

These points cannot be stressed too much: Pentothal given by syringe is dangerous and solution strengths above 1 per cent are not safe. On the other hand, the intravenous drip method with solution strengths of 1 per cent and below are not dangerous and can be administered by any average anesthetist. With the syringe method you are pouring into the blood

stream and respiratory center far too much potent solution, far too rapidly and at uneven intervals. Under such circumstances the respiratory center does not wake up as fast as the corneal reflex and muscular movements. In the slower, more even intravenous drip method of 1 per cent solution at 60 drips a minute the respiratory center keeps pace with the corneal reflex and muscular movements so that the anesthetist has more accurate guides to the condition of the respiratory center and thereby avoids disaster.

*Postoperative Care.* We had a run of pulmonary complications for a while. None of these proved serious but our incidence of atelectasis and postoperative pneumonia, or at least cyanosis, was slightly increased. This was found to be caused by the same trouble that we first had on induction. When the patient is coming out of intravenous anesthesia, we frequently noted mild contractions of the diaphragm which brought up stomach contents to an insensitive pharynx and larynx, with subsequent pulmonary aspiration. To prevent this we ordered the foot of the bed raised on all postoperative patients and instructed a nurse to stand by with an aspirator and tongue blade until the patient was fully awake. We did this in all types of cases, even thyroidectomies, thereby ignoring an old dictum to elevate rather than lower the operative part.<sup>20</sup>

One side effect of raising the foot of the bed in all postoperative cases is of extreme interest. Our incidence of pulmonary embolism promptly decreased. Our explanation of this seemed to be that elevation of the foot of the bed did not allow stagnation of blood in the veins of the lower extremities where it could clot. In addition, the patients awake very soon after the operation and stir around. We began to encourage patients to move about as soon as they were awake and they now are actively hyperventilated by deep breathing, leg and arm exercises and frequent turning. Now that such sutures as tantalum wire and cotton are in vogue, some of our surgeons

have their patients who have undergone major operative procedures in a chair the day after operation.

Two other precautions against embolism may have helped us, however. First, we never put a tight strap across the knees on the operating table because loose ankle hobbles hold the patient satisfactorily. Second, pillows under the knees postoperatively are strictly forbidden. Our incidence of pulmonary embolism as found at postmortem in the two hospitals is a fairly accurate index because we average 38 per cent postmortems in all deaths at Sioux Valley Hospital and 52 per cent at McKennan Hospital. Table 1 shows the incidence of postoperative pulmonary embolism.

TABLE 1

	Per Cent	1940	1941	1942	1943	1944	1945	1946
McKennan Hospital.	52	2	0	0	0	0	0	0
Sioux Valley Hospital	38	0	0	2	0	0	0	1

The higher incidence of embolism at Sioux Valley is justified because most of the elderly prostatic resections and severe accident cases go to this hospital. Also it is a larger hospital and more operations are done there.

*Pentothal Alone.* As to the use of pentothal alone for major operations, patients vary in their tolerance<sup>4,8-10</sup> to the anesthetic; and when we find a patient who is not tolerating intravenous pentothal well, we switch to any type of inhalation anesthetic that benefits the patient. All types of inhalation anesthetics can be given with pentothal or interchanged with it. Most patients react well to pentothal, however, and we have no hesitancy in using it alone for major procedures regardless of the length or formidability of operation. Another reason for adding or changing to an inhalation anesthetic is to get more abdominal relaxation and it is better to switch than to overdose with pentothal. Pentothal does not always give enough abdominal relaxation and curare is too



transient for an operation requiring prolonged abdominal relaxation. When pentothal is used alone, curare is given in opening the peritoneum and at closing. To illustrate, the figures for 1946 at McKennan Hospital show that there was a total of 2,739 surgical procedures and 647 of these, such as opening eustomies, etc., required no anesthetic. There were 2,092 anesthetics of all kinds given. Of this total, 1,154 or better than 50 per cent were intravenous alone or in combination, and the remainder (938) less than 50 per cent were other anesthetics. Considering the large number of tonsillectomies done under ether and local anesthetics, this is a good percentage. Glancing at the figures for major anesthetics, which number a total of 978 with 676 of these under pentothal alone or in combination, one sees that better than 68 per cent of all major operations were done under pentothal alone or in combination. (Table II.) Breaking this down further, we find that 237 of the total, or 24 per cent of our major operations are done under pentothal alone.

TABLE II

MCKENNAN HOSPITAL 1946

Total surgical procedures.....	2,739
Procedures without anesthesia....	647
Total anesthetics.....	2,092 (including local)
Intravenous anesthesia.....	1,154 (alone or in combination)
Other anesthetics.....	938
Anesthesia in major operations...	978
Anesthesia in minor operations...	1,114
Intravenous anesthesia in major operations.	676 (237 were intravenous alone)
Other anesthesia in major operations.....	202 (general)
Intravenous anesthesia in minor operations.	488 (272 were intravenous alone)
Other anesthesia in minor operations.	736 (general and local)

A great deal has been written about the danger of giving too much pentothal<sup>2,8-10,21</sup> or giving it in prolonged operations. We have given as much as 66 gr. (4.290 Gm.) without ill effect. We note in going over our records that many of our formidable major operations in which pentothal alone was used lasted three or four hours. When a mask or nasal catheter can be used, we

usually give 100 per cent oxygen throughout the operation when pentothal alone is administered. We rarely give picrotoxin and only occasionally administer metrazol.<sup>15</sup>

#### *Pentothal in Combination.* 4,5,7,13,19,24,25

I do not have the statistics for Sioux Valley Hospital for 1946 but the anesthetic trend is the same in both hospitals. One can see from our statistics at the McKennan Hospital for 1946 that 44 per cent of the intravenous anesthetics were given in combination with an inhalation anesthetic. The reason for this is apparent when one remembers that most general surgery is done in the abdomen where muscular relaxation is needed. Our procedure is usually an induction with pentothal-oxygen and a gradual conversion to cyclopropane. We use a No. 20 needle and have a Y tube connection, with the pentothal on one limb of the Y and normal saline or 5 per cent glucose hooked on the other limb of the Y. Thus, we frequently give fluids during the operation and none has to be given postoperatively. There are roller stops on each limb of the Y so that each limb may be shut off or slowed instantly if desired. If blood must be given during the operation, one limb of the Y is disconnected and attached to the blood bottle. In formidable procedures in which shock is sure to develop we do not wait for signs of shock but start the transfusion early in the operation. Any intravenous medication required during the operation is administered directly through the sterile rubber tubing which goes to the arm vein.

We have purposely emphasized the use of this anesthetic in major<sup>14-17</sup> operations and have not classified all the minor procedures because they are relatively unimportant in this discussion, since intravenous anesthesia is widely used for minor but not for major procedures. In our classification of major procedures some headings will need a word of explanation. (Table III.) For instance, under the heading "combined operations" are listed operations that include more than one procedure,

such as cholecystectomy and appendectomy, hysterectomy and appendectomy or laparotomy and vaginal combination. Under the heading "bowel resections" are included traumatic lesions and acute obstructions principally. The brain operations

TABLE III

	Mc-Kennan Hospital	Sioux Valley Hospital	Total
Abdominal adhesions.....	24	15	39
Abdominoperineal resections..	1	6	7
Appendectomy.....	953	808	1,761
Bowel resection.....	13	12	25
Brain operations.....	3	1	4
Cesarean section.....	14	13	27
Cholecystectomy.....	97	78	175
Cholecystgastrostomy.....	1	0	1
Combined operations.....	348	321	669
Exploratory laparotomy.....	21	16	37
Eyc operation—major.....	26	15	41
Gastrectomy.....	4	6	10
Gastroenterostomy.....	14	10	24
Hernia repair.....	290	259	549
Hysterectomy.....	89	82	171
Laminectomy.....	1	0	1
Lobectomy (thyroid).....	2	1	3
Mastectomy.....	45	47	92
Nephrectomy.....	1	1	2
Orthopedic operations—major	68	283	351
Pelvic laparotomy.....	165	148	313
Perforated peptic ulcer repair	12	5	17
Prostatic resection.....	21	99	120
Thyroidectomy.....	16	22	38
Unclassified major surgery....	107	66	173
Ureteral calculus removed....	1	0	1
Splenectomy.....	1	1	2
Kidney stone.....	0	1	1
Total majors.....	2,340	2,316	4,656
Minor operations.....	1,011	2,027	3,038
Total intravenous anesthetics	3,351	4,355	7,694

comprise extradural and subdural hematomas, depressed fractures with dural tears and foreign body penetrations. The exploratory laparotomies cover mostly inoperable carcinomas or palliative operations for carcinoma.

## SUMMARY

1. A survey of the use of intravenous pentothal sodium alone and in combination has been given with particular emphasis on major surgery.

2. Over 7,000 cases have been cited, 4,656 of which were major procedures. There were no anesthetic deaths or serious complications that can be attributed to the anesthetic.

3. A safe preoperative, operative and postoperative routine has been outlined.

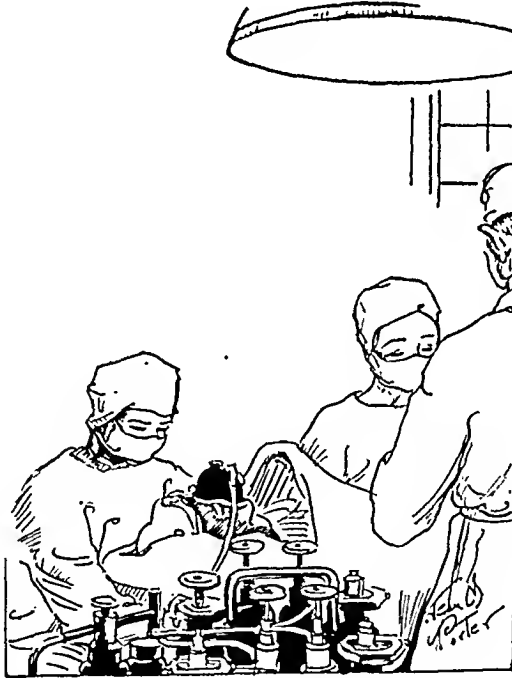
4. The advantages of intravenous anesthetics, alone or in combination, compared to other anesthetics alone or in combination are: (a) quicker, smoother induction without anxiety on the part of the patient. (b) quicker, smoother postoperative recovery with much less nausea and vomiting, gas pains or acute dilatation of the stomach; (c) fewer complications postoperatively.

5. In the light of our experience we are inclined to believe that most disturbances with intravenous anesthetics are due to improper pre- and postoperative management and faulty administration.

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# WOUNDS OF COMMON CAROTID ARTERIES

## REPORT OF SEVENTEEN CASES FROM WORLD WAR II

KNOWLES B. LAWRENCE, M.D.,\*  
*Brookline, Massachusetts*

LAWRENCE M. SHEFTS, M.D.\*  
*San Antonio, Texas*

AND

JOHN R. McDANIEL, M.D.\*  
*St. Joseph, Missouri*

IT is well known that sudden interruption of blood flow through a common carotid artery will lead to cerebral ischemia and eventual death or hemiplegia in a high percentage of cases. Common carotid ligation in peace time, including elective cases, appears to carry a mortality rate of 20 to 50 per cent.<sup>1</sup>

War wounds of this artery might be expected to result in an even higher mortality. The most significant reports available on this subject are those of British surgeons based on their experience in World War I. Makins in his monograph<sup>2</sup> states that he never saw a successful case of primary ligation of the common carotid artery in four years service as consultant to lines-of-communication hospitals. He observed that in virtually all cases of carotid wounds reaching forward hospitals alive the external wounds were very small and the injury to the artery was "minor, lateral or through-and-through." Most of the eighty-five patients in Makins' personal series were treated conservatively or had delayed surgery for secondary hemorrhage, aneurysm or fistula, infection or a foreign body. Ten of the eighty-five manifested well established arterial aneurysms and forty-eight had arteriovenous aneurysms or fistulas. The relatively low mortality rate of 15.2 per cent for his series represented, of course, only a portion of the total mortality of those with carotid wounds.

In the general report of the British medical services<sup>3</sup> covering 128 wounds of the carotid arteries treated in both forward

and base hospitals during World War I a death rate of 16.4 per cent is recorded. The incidence of cerebral complications was 29.6 per cent with a fatal outcome in 55.3 per cent of such complicated cases. As in Makins' series the initial handling of the majority of these 128 carotid wounds was conservative, ligation and other surgery being performed chiefly for the various complications. It is impossible to judge from these publications how many other patients with undébrided neck and carotid wounds died of primary or secondary hemorrhage, sepsis or other causes.

Only twenty-five carotid artery wounds among the American forces were reported by the U. S. Army Medical Department for World War I.<sup>6</sup> The mortality rate for this group was 44 per cent but no further particulars were given.

In reviewing a series of 661 instances of major arterial wounds treated surgically in certain forward army hospitals of the Mediterranean and European theaters during World War II by teams of the Second Auxiliary Surgical Group, seventeen cases of wounds to a common carotid artery were encountered. These patients were treated as early as possible after wounding; the surgical facilities were good and the after-care generally adequate. It is interesting, therefore, to analyze these cases and, in particular, to compare the fatality rate with those pertaining to such wounds in the first world war. No instance of a wound of internal carotid artery alone or of both common carotids were found in this series. There was, in addition, one

\* Formerly members of The Second Auxiliary Surgical Group, United States Army.

TABLE I  
INJURIES OF THE CAROTID ARTERIES

Case No.	Age	Time Lag	Shock	Preoperative Examination	Associated Injuries	Type and Degree of Vessel Injury	Operative Procedures		Recoveries		Comment and Follow-up	Post-operative day	Deaths	Cause
							Vessel	Other	Cerebral Signs	Day Evacuated				
I	19	4 hr.	No	Conscious; right Horner's syndrome paralysis; right diaphragm; no hemiplegia	Transected right phrenic and recurrent laryngeal nerve; contused sympathetic chain	Right C.C.† severed	Ligation of artery; elective ligation of internal jugular vein	None	None	7	Also had hemiparalysis of vocal cords	.....	0	
II	..	8 hr.	Mod-erate	Conscious; no hemiplegia	Contusion of fifth and sixth cervical nerves	Left C.C. lacerated at bifurcation	Ligation of C.C., external and internal carotid and vertebral arteries left	None	Right hemiplegia; left facial paralysis	7	.....	.....	0	
III	29	2½ hr.	No	Conscious; no hemiplegia	0	Left C.C. lacerated, near aorta and connected by fistula to internal jugular vein	Quadruple ligation	None	None	6	Left-sided headache postoperatively	.....	0	
IV	..	2 hr.	No	Conscious; no hemiplegia	Sucking thoracic wound	Right C.C. lacerated near origin	Ligation right C.C.	Closure of sucking wound	.....	..	Immediate postoperative hemiplegia	2	..	Encephalomalacia
V	25	....	Severe	.....	Perforation of trachea	C.C. severed	Ligation, C.C.	Tracheotomy	None	3	No hemiplegia on 18th postoperative day	.....	0	
VI	..	11½ hr.	No	Conscious; no hemiplegia	0	Right C.C. lacerated	Ligation right C.C.	Tracheotomy	Left hemiplegia; lethargy	1	Hemiplegia and lethargy improving at time of evacuation	.....	0	
VII	21	15 days	.....	Conscious; no hemiplegia	Penetrating wounds of face	Right C.C. lacerated	Ligation right C.C.	Tracheotomy	None	..	Original operation was tracheotomy; C.C. ligation for hemorrhage on 18th postoperative day	.....	0	
VIII	19	36 hr.	.....	Conscious; no hemiplegia	F.C.C.* maxilla and mandible	Left C.C. lacerated	Ligation left C.C.	None	None	..	.....	.....	0	Encephalomalacia
IX	..	8 hr.	.....	Unconscious	F.C.C., thyroid cartilage; penetrating wounds of arm and shoulder	Left C.C. lacerated at bifurcation	Ligation of C.C. external and internal carotid arteries	None	.....	..	.....	10	..	Encephalomalacia
X	..	....	Severe	Conscious, quadriplegia and right facial palsy	Contused superior and median cords of brachial plexus and phrenic nerve	Left C.C. thrombosed and left internal jugular vein lacerated	Ligation left internal jugular vein	None	.....	..	Autopsy showed thrombosed left C.C. artery	4	..	Encephalomalacia

\*F.C.C.—Fracture compound, comminuted.

†C.C.—Common carotid

TABLE I—(Continued)

Case No.	Age	Time Lag	Shock	Preoperative Examination	Associated Injuries	Type and Degree of Vessel Injury	Operative Procedures		Recoveries		Comment and Follow-up	Post-operative Day	Deaths	Cause
							Vessel	Other	Cerebral Signs	Day Evacuated				
XI	19	6½ hr.	.....	.....	.....	C.C. perforated	Ligation of C.C. and removal of damaged segment	0	.....	13	.....	.....	0	.....
XII	24	9½ hr.	.....	No hemiplegia	Penetrating wound of thorax	Left C.C. lacerated near origin	Ligation of C.C.	.....	.....	..	Had hemiplegia postoperatively	2	..	Encephalomalacia
XIII	24	3½ hr.	Severe	Conscious; no hemiplegia	Perforation of cervical esophagus; contusion of left phrenic nerve	Right C.C. lacerated near origin; right internal jugular vein and left vertebral artery transected	None	Tracheotomy	.....	..	.....	Same day	..	Died before operation of hemorrhage from left vertebral artery into pleural cavity
XIV	..	.....	.....	Conscious no hemiplegia	Penetrating wound of thigh	Left C.C. lacerated	Ligation of C.C.	Debridement	.....	..	Semicomatosely postoperatively	3	..	"Cerebral death," no autopsy
XV	..	4½ hr.	No	Left hemiplegia	0	Right C.C. lacerated just before bifurcation; internal jugular vein severed	"Blakenmore cuff" anastomosis using saphenous vein; internal jugular vein ligated	Tracheotomy	.....	..	Semicomatosely postoperatively; partial recovery from hemiplegia by fourth postoperative day	19	..	Encephalomalacia
XVI	18	2½ hr.	No	.....	Penetrating wounds of knee, thoracic wall and face	Left C.C. intima bulged through laceration in muscularis; left subclavian vein lacerated at junction with internal jugular vein	Inversion of aneurysm and suture of muscularis, ligation of veins	None	None	2	No interruption of blood flow at any time	0	0	.....
XVII	..	.....	Severe	No hemiplegia	Contusion of left cervical sympathetic	Left internal carotid artery thrombosed and left external carotid artery severed	Left external carotid artery ligated	Tracheotomy	.....	..	.....	9	..	Encephalomalacia; thrombosis of internal carotid artery extending into cerebral vessels

case of laceration of the innominate artery treated by ligation since suture was not technically possible. The patient died of mediastinal infection and encephalomalacia.

#### CLINICAL DATA

Table I presents the pertinent clinical data available to us in the cases of common carotid wounds. These patients were young, the average age being twenty-two years. This probably was a factor in their favor since the cerebral circulation seems capable of greater adaptation in youth. The time lag from wounding to surgery was recorded in thirteen cases. In one of these a small wound of the common carotid was not identified until the eighteenth post-wound day when sudden hemorrhage from the wound occurred. Excluding this case the average time lag for the others was 11.6 hours, approximately the same time lag as for the abdominal wounds in the Group's experience and probably the minimum possible under the prevalent tactical conditions. Undoubtedly by that time some irreversible changes due to blood deprivation had occurred in the cerebral tissue of three of these patients. This must always remain a limiting factor in prognosis no matter how technically satisfactory the surgical procedures for restoration of arterial continuity may seem.

Some notation of the preoperative neurologic status was found in the forward hospital records in fourteen of the seventeen cases. (Table II.)

TABLE II  
RELATION OF PREOPERATIVE NEUROLOGIC STATUS TO  
OUTCOME IN FORWARD HOSPITALS (14 CASES  
RECORDED)

No Neurologic Signs	Neurologic Signs Present
Survivals..... 6	Deaths..... 3
5 survived, asymptomatic	All died of encephalomalacia
1 survived with cerebral signs	
Deaths..... 5	
4 died (encephalomalacia)	
1 died of hemorrhage (before ligation)	

Of these fourteen patients, eleven were conscious and had no hemiplegia or gross

signs of cerebral ischemia prior to surgery; one was unconscious, one manifested a quadriplegia and one a hemiplegia. These last three patients all died and showed encephalomalacia at autopsy. The common carotid was ligated in ten of the eleven patients who presented no neurologic signs preoperatively. Only five of those recovered without objective signs of cerebral damage; four died with encephalomalacia and one had hemiplegia and lethargy, improving at the time of evacuation to another hospital. The one remaining patient with no cerebral signs preoperatively died of hemorrhage from a severed vertebral artery before carotid ligation could be undertaken.

Study of the type and magnitude of the arterial wound in relation to the recovery of the patient was not very informative. For example several patients with perforation or laceration of an artery requiring ligation when exposed during wound débridement, went on to complete recovery whereas in two patients without an actual wound of the arterial wall, occlusion by thrombosis resulted in encephalomalacia and death. It seems likely that the extent and spread of thrombosis in the arterial tree and the quality of the pre-existing collateral circulation to a hemisphere are the two most potent factors in prognosis for common carotid wounds although both are quite unpredictable clinically.

#### RESULTS OF SURGICAL TREATMENT

The common carotid artery was ligated in twelve of the seventeen patients.

As shown in Table III six of these patients survived without any cerebral manifestations. Two others developed hemiplegia but showed improvement at the time of evacuation. Thus, 66 per cent of the twelve ligated patients survived relatively sudden interruption of the common carotid blood flow on one side.

One of the five unligated patients was treated by primary anastomosis of the lacerated artery, using the Blakemore non-suture method.<sup>4</sup> In this patient the time

lag from wounding to operation was only four and one-half hours but he was hemiplegic preoperatively. This condition persisted and he died with encephalomalacia on the nineteenth postoperative day. A second patient had only a tracheotomy and

TABLE III  
RESULTS OF SURGICAL TREATMENT OF COMMON CAROTID  
WOUNDS (17 CASES)

Surgical Procedure	Lived	Lived with Cere- bral Signs	Died
Ligation (12 cases).....	6	2	4
Anastomosis.....	..	..	1
Suture of incomplete lacera- tion.....	1		
No surgery			
Thrombosis.....	..	..	2
Hemorrhage.....	..	..	1
Vertebral artery hemorrhage			
Totals.....	7	2	8

died shortly thereafter due to hemorrhage from a coincidental wound of a vertebral artery before carotid ligation could be undertaken. In a third case the laceration involved only the outer layer of the carotid wall resulting in a small aneurysm. The blood flow was not interrupted and, of course, the patient did well. In two patients the common carotid became completely thrombosed, a lesion which either developed after operation or was unappreciated at that time. The cerebral involvement was fatal in both cases.

The series included one instance of acute A-V fistula, i.e., between the common carotid and internal jugular vein. This was treated by quadruple ligation two and one-half hours after wounding with resultant recovery.

The overall mortality of the seventeen patients with common carotid artery wounds during their forward hospital stays was 47 per cent.

#### COMMENT

The mortality rate for wounds of the common carotid artery in our small series

of seventeen cases was 47 per cent. This was the case notwithstanding various advances in the care of the wounded in World War II, such as improved evacuation, excellent forward surgical hospital facilities and the general use of plasma, blood, sulfonamides and penicillin. It is impossible to compare these figures, of course, with the much lower mortality rates reported by the British for World War I for the following reason: Eleven of our seventeen patients received early emergency ligation of the artery, whereas in most of the cases in the British series the surgery, including ligation was delayed and was performed only for established aneurysms or arteriovenous fistulas, for secondary hemorrhage or incidental to surgery for infection or a foreign body.

Although certain of our surgical teams were equipped to do Blakemore-non-suture anastomoses during the latter part of the European campaign, in only one of the cases of carotid injury reported was this actually performed. No other types of anastomoses were attempted, usually because too great a length of the vessel had been destroyed or the patient's condition would not permit a prolonged operative procedure. Heparin was not available.

It is worthy of re-emphasis that six patients with no hemiplegia or other significant cerebral symptoms preoperatively developed these complications after ligation. Serious hemorrhage constituted a positive indication for exposure of the carotid artery and its ligation in several of our patients. In others, however, débridement of the neck wound was done as a routine procedure. The reactivation of hemorrhage as the carotid wound was exposed was not always anticipated and could be controlled only by immediate ligation. No patient was treated conservatively by intention. The one patient in whom the arterial wound had plugged itself initially and the artery was not ligated until the eighteenth post-wound day for secondary hemorrhage, recovered without cerebral complications, perhaps because



the collateral circulation had improved in the interval. It would seem, therefore, that immediate ligation of a common carotid artery is highly hazardous and is to be avoided whenever possible.

Several writers<sup>2,3,5</sup> have argued for conservatism in the initial treatment of suspected or known wounds of major arteries if the bleeding appears to have stopped, in the hope that sufficient blood might continue to pass through the lumen of the damaged vessel until adequate collateral circulation developed. The application of this principle was credited with considerable success in wounds of the common carotid (as well as other major arteries) during World War I<sup>2,3</sup> although it is impossible to ascertain from these reports the extent of loss of life and limb consequent on the omission of débridement. It is barely possible that several of the patients in our series (Cases IV, XII and XIV for example) might have survived if handled conservatively with ligation only as required by complications. One gathers, however, that most of the wounds in this series were more severe than the non-fatal cases described in the British series alone. Undoubtedly, a higher percentage of the seriously wounded survived to reach forward and base hospitals in World War II than in the first world war due to improvements in resuscitation and transport. These factors make comparisons difficult.

Occasionally a perforating wound of the neck, due to a bullet or other high velocity missile in which the danger of infection is much reduced, may prove suitable for conservative management. The handling of suspected carotid wounds should be individualized with this possibility in view.

If hemiplegia or other cerebral signs are present preoperatively however, there probably is no point in conservative handling. What little chance of recovery remains to such a patient may be enhanced by making sure he has no further hemorrhage or sepsis factor to contend with.

Despite the apparent attractiveness of

conservative handling, we favor early débridement of neck wounds as a general policy because of the threat of serious infection and its complications, including uncontrollable secondary hemorrhage, if such débridement is omitted. Although impossible to prove by available statistics, we think this radical policy will save more lives if generally followed than would conservative management. One should, of course, constantly bear in mind the possibility of injury to a carotid in any wound of the neck and be alert for such telltale signs as massive hemorrhage, pulsating hematoma and cerebral signs. Once such a lesion is suspected the patient should be operated upon as soon as possible by a team technically equipped to perform an anastomosis or other blood vessel surgery as indicated. A good supply of blood should be running into a vein. Heparin should be available for injection into the arterial lumen and postoperative heparinization should be instituted if anastomosis is accomplished.

#### RESTORATION OF ARTERIAL CONTINUITY

End-to-end arterial suture<sup>7</sup> has long been recognized as a theoretically ideal method for restoration of continuity in an interrupted major artery. This did not become a practical reality, however, until Murray<sup>8</sup> demonstrated the efficacy of heparin in the prevention of intravascular clotting, particularly at the suture line. Suture anastomosis of major arteries in experimental animals and in elective arterial surgery are quite different matters from the performance of similar operations in war wounds. It was our observation in World War II that loss of substance of an artery, as was frequently the case in such wounds, made it virtually impossible to approximate the ends for suturing. These patients often were in a critical condition despite resuscitative measures and were poor candidates for tedious operative procedures. Forward operating teams lacked the time and facilities when other casualties were pouring in for the painstaking

dissection and meticulous suturing necessary in a successful suture anastomosis. In the particular case of the wounded common carotid artery it is obvious that the time factor is vital. Suture anastomosis of this artery requires complete interruption of blood flow through it by arterial clamps or temporary ligature until the necessary mobilization of the arterial segments has been completed and the suture anastomosis performed, a matter of an hour or more in the most skillful hands. This deprivation of blood supply may be quite sufficient to cause irreparable and fatal cerebral damage to a patient whose brain was still receiving a minimum necessary blood flow through a damaged but not completely occluded vessel until surgery was begun. The same limitations apply to venous grafts for these were found to be difficult and too time-consuming whenever attempted during the war.<sup>9</sup>

Successful restoration of blood flow through a wounded carotid artery might then depend on some form of cannulization or intubation which could be accomplished in only a few minutes' time and with minimal mobilizations of the vessel ends.

Tuffier<sup>1</sup> performed many such cannulizations of wounded major arteries of extremities during World War I, using silver or glass tubes. The procedure usually was unsuccessful because the tubes and adjacent vessel segments became occluded by thrombosis in a short time. Murray and James<sup>11</sup> in 1940 reported a series of successful arterial intubations with glass cannulas in dogs. They were able to prevent thrombosis and maintain circulation for indefinite periods by adequate administration of heparin. They suggested logically that such cannulization be employed in arterial wounds during the current war as a temporary measure to maintain some blood flow to a part until adequate collateral circulation had developed or axial suture or vein graft could be performed with greater chance of success.

Blakemore, Lord and Stefko in 1942<sup>4</sup>

added the further refinement of a Vitallium tube or tubes lined with a segment of vein. They attributed their high percentage of successful anastomoses in dogs, even without the aid of heparin, to avoidance of bacterial infection and of damage to the exposed intima of either the artery or the vein segment by their method of non-suture anastomosis. As indicated in the report of DeBakey and Simone,<sup>9</sup> the Blakemore anastomosis method proved too technically difficult and time-consuming in actual practice for wide application. In a small group of wounded major arteries anastomosed in this way there was only 50 per cent limb salvage, no improvement over initial ligation in larger groups of similar cases.

Mustard<sup>12</sup> of the Royal Canadian Army Medical Corps has reported somewhat promising results for immediate restoration of arterial continuity in actual war wounds. He adapted the method of temporary cannulization plus heparinization, as advocated by Murry and Janes, to fifteen instances of war wounds of major peripheral arteries. Although the percentage of limb salvage was low due in part to the time lag between wounding and surgery and to infection, he found it possible to maintain the cannulas patent and unthrombosed when heparinization was adequate. There was one common carotid wound in this group. Although the cannula was left in place only eight hours and ligation of the artery was done at that time, the patient recovered without cerebral difficulties.

In Mustard's cases the wounds were débrided as soon as possible after wounding. Immediately on exposure of the wound in the artery he removed all accessible clot and perfused the distal arterial tree with a solution of heparin in physiologic saline. He then inserted a glass or plastic tube of suitable length and caliber into the vessel ends to budge the defect or damaged segment and secured it with encircling ligatures. Local and general heparinization was then instituted. Such an anastomosis was temporary, of course, for after several

days the vessel ends would be cut through by the encircling ligatures. Before such an accident was calculated to occur Mustard re-explored the wound and performed an anastomosis by suture or vein graft, reinserted a new tube or, if the collateral circulation seemed adequate, simply ligated the vessel.

A temporary intubation anastomosis of this type may permit sufficient blood flow to nourish the parts until an adequate collateral circulation has developed. Technical advantages of this procedure as an emergency measure over suture anastomosis or non-suture anastomosis of the Blakemore type are that it should require much less time, less technical skill and less mobilization of the arterial segments with possible injury to collateral vessels, factors which have contributed to the disappointing results of initial formal anastomosis for acute arterial injuries. Mustard demonstrated the feasibility of carrying out this plan of treatment, including heparinization, in British forward military hospitals.

Two technical developments which may prove useful adjuncts to Mustard's method of handling major arterial wounds have been reported in recent months. These may be of particular value in common carotid wounds. Jenkins<sup>13</sup> has demonstrated the value of wrapping pads of gelatin sponge reinforced by cuffs of fascia about injured or cannulated major arteries to strengthen the local segments and to inhibit secondary hemorrhage. It seems likely that such a reinforcement could be applied quickly about a cannulated carotid artery. The other development reported by Hufnagel<sup>14</sup> is the successful "permanent" intubation anastomosis of the thoracic aorta in dogs with highly polished tubes of a plastic lucite. For some unexplained reasons thrombosis did not take place in these tubes or in the adjacent arterial segments although systemic anticoagulants were not used. After experimentation Hufnagel found that an especially braided Deknatel ligature for tying the lucite tube into the arterial ends avoided the

usual necrosis of the arterial wall at this point and resultant rupture of the anastomosis.

A fibrous union developed and the intubations became in effect permanent. This method might well be successful in war wounds of the common carotid artery.

These observations on war wounds involving the common carotid artery have an obvious bearing on peacetime wounds or injuries to this structure. Differences in the situation of the injured civilian from that of the wounded soldier such as the usual single wound of the civilian, the decreased liability to serious wound infection, the shorter time lag before definitive care and the ability to hold the patient at one point without necessary evacuation are all in favor of the injured civilian. Except for the single factor that the civilian may be older than the soldier these advantages should result in a lower mortality rate for those with peacetime injuries.

It is suggested, therefore, that arbitrary ligation of the common carotid artery, often made necessary by circumstances in war casualties, be avoided whenever possible in peacetime injuries and that anastomoses of either the temporary or permanent type plus immediate heparinization be attempted more generally.

#### SUMMARY

A series of seventeen wounds involving the common carotid artery is reported from experiences in certain forward army hospitals during World War II.

The artery was ligated in twelve patients and eight of these survived, with cerebral signs (transient hemiplegia) in only two cases. Of the five unligated patients four died, two from arterial occlusion by thrombosis, one due to coincidental hemorrhage from a severed vertebral artery and one following arterial anastomosis (Blakemore method).

The overall mortality rate for this series was 47 per cent.

The authors prefer early débridement and direct attack on the arterial wound to conservative management of suspected common carotid wounds.

Immediate ligation of this artery is highly hazardous, however, and should be avoided whenever possible.

Recent improvements in surgical methods for restoring blood vessel continuity and the circulation distally, notably by cannulization, may reduce the mortality rate somewhat and should be employed. The unavoidable time lag before surgery under combat conditions and inherent inadequacies in cerebral collateral circulation shown by many individuals, however, probably will maintain this rate at a relatively high level.

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# PLACENTAL BLOOD AND PLACENTAL EXTRACT IN WOUND HEALING

FRANK R. COLE, M.D.  
*Flushing, New York*

PLACENTAL blood was used in combination with the extract of placental tissue in cases of chronic granulating wounds of the varicose ulcer decubitus variety. Analyses of the results were compared to other forms of therapy which were used on the same patient and, if possible, on the same wound if a large enough area was present.

Virehow,<sup>1</sup> in 1858, suggested that healing was due to the direct stimulation of cells by traumatism. Carrel,<sup>2</sup> Carrel and Burrows<sup>3</sup> and Carrel and Ebeling<sup>4-6</sup> believed that growth activity could be attributed to the split products of proteins, the polypeptides, and also that glutathione and hemoglobin *per se* seemed to exercise a proliferative fibroblastic activity. The latter observation is a prophetic observation on present day research initiated by Moorehead and Unger on the healing property of red blood cells.

Hammett<sup>7-11</sup> and Hammett and Reimann<sup>12</sup> did a great deal of work in wound healing. Their conclusion from plant and animal experiments was that the sulfhydryl group was the essential stimulus for wound healing and proliferation. Greenbaum,<sup>13</sup> in 1936, put forward the claim that allantoin, which was discovered by Robinson,<sup>14</sup> was a cell stimulant. This confirmed Robinson's work and a great deal of enthusiasm was shown by clinicians in the use of this substance. Shipp and Hetherington,<sup>15</sup> however, found that the substance failed to stimulate tissue cultures. Holder and MacKay<sup>16</sup> still regard its action as antibacterial if not growth stimulating.

Carrel<sup>2</sup> showed that extracts of several days' old chicken embryos had the remarkable property of accelerating and maintaining *in vitro* growth of fibroblasts. Carrel and

Ebeling<sup>4-6</sup> showed that homologous and heterologous adult organ tissue accelerated the *in vitro* growth of fibroblasts but did not maintain its growth indefinitely. In 1913 Carrel<sup>17</sup> suggested the use of pulped tissue in wound healing. Since then, many workers have attempted to assess the value of embryonic tissue extracts without avail. Wallich<sup>18</sup> and Nakamura<sup>19,20</sup> reported favorable results from the application of embryo extracts to the experimental wounds of guinea pigs. Morisov and Striganova<sup>21</sup> used an extract of human embryos on wounds with good results. These reports are in direct contrast to the work of Dvorak and Byram<sup>22</sup> and Dann, Glucksmann and Tansley<sup>23</sup> who failed to demonstrate any acceleration in growth. Young, Fisher and Young<sup>24</sup> finally wrote in their article that the reason there is so much discrepancy in results is that the various authors do not evaluate their experimental and clinical results sufficiently.

In 1943 Mandl and Maybaum<sup>25</sup> reported a great number of successes with the use of heart muscle extract in wound healing. Kerr and Werner<sup>26</sup> found that minced heart muscle when extracted and the powder used on lesions daily caused healing to take place in chronic indolent wounds. Goldberg<sup>27</sup> working in Russia found that embryonal emulsions of chick embryos used in the form of ointments caused the rapid healing of bed sores, burns and ulcers. This work done over a two-year period was verified on experimental animals. He found that his preparation caused stimulation of fibroblasts and epithelium. The wound exudates diminish and granulation tissue appears more extensively. This now takes us to the concept of Carrel,<sup>28</sup> in 1923, that the injured tissues

elaborate a hormone or trephone that causes the healing of wounds. This is merely the elaboration of his earlier theories.

In 1942 Cook and Fardon<sup>29</sup> took up the work of Carrel, and their evidence is that living cells form a hormone-like substance that causes proliferation of fibroblasts as result of injury. They show by tissue cultures that successive traumatization causes these cultures to grow faster. The isolation of these substances at present is unknown although some have been identified as biotin, thiamin and inositol.

This review of the literature, although related distantly to the work done in this paper, forms a background of the work on cell growth and proliferation. Dempsey and Wislocki<sup>30</sup> state that the placenta contains a high amount of estrogens and progesterone; these substances are elaborated and stored. The high amount of hormones plus the large quantity of glycogen, iron and vitamin C are all the factors that are necessary in wound healing.

Murray and Shaar<sup>31</sup> applied fresh red cells mixed with tragacanth and hexyl-resorcinol to chronic indolent wounds. They, as well as Moorhead and Unger<sup>32</sup> who were the first to use it in chronic granulating wounds, found that the type of lesion that responded best was the one that failed to maintain the usual process of repair due to circulatory disorders. When the red cell mass was applied to a superficial wound, it formed an impervious coating which finally became adherent to the wound; but when applied in larger amounts it was found to be absorbed to a degree. This mass was applied to sixty-six patients, and only four did not respond.

Naide<sup>33</sup> withdrew blood from the antecubital vein and applied it directly to the surface of a chronic ulcer. The patient had immediate relief from pain and on second application had a subsidence of reaction. When Naide found that blood could heal chronic ulcerations, he tried concentrated plasma. This proved to the author to be more effective than whole blood. He found

that only two of fifteen patients failed to heal. Naide also mentions the fact that pain subsided in one to two applications.

Seldon and Young<sup>34</sup> also have used red cells in wounds and also report excellent results, with subsidence of pain in the patients with indolent granulating wounds. Lundy and Adams<sup>35</sup> report that presence of the blood seems to be a stimulating effect on the growth of vascular and connective tissue. They think it is glutathione that is responsible for the beneficial effect on the increased growth of connective tissue.

In the patients studied the following mixture was used: The placental blood was collected aseptically in sterile pans. When possible, the blood was collected from many patients. There was one patient with placenta previa and one with premature separation of the placenta. The amount of placental blood collected on an average from each patient ranged between 75 to 80 cc. The pooled blood was from different blood types. They all had negative Wassermanns and normal temperatures. The blood was then mixed with sterile K-Y jelly so that the consistency was that of a paste. Enough of the mixture was on hand to treat one-half dozen patients. A blood sample analysis showed a red cell count of 3.6 to 4.7 million red cells and from 6 to 11,100 white blood cells. It must be noted that the mass of red cells before being used was mixed with an extract of placenta. This extract was obtained by squeezing the placentas of the same patients whose blood was used. The serum was blood-tinged and had the consistency of paste. All these patients were treated systematically for the etiologic cause when possible, viz., insulin for diabetes, etc. In some cases if the wound was large, a comparative study was made with pooled blood from the bank.

#### CASE REPORTS

CASE I. J. A., aged sixty-eight, was admitted with the history of slipping on the ice and falling on his right side. He was unable to

raise himself off the ground. The patient was admitted by ambulance, complaining of pain in his right hip, inability to flex his hip or move his leg.

Examination revealed an elderly male of stated age who held his foot in eversion, had tenderness over the greater trochanter and was unable to adduct or abduct his right foot. X-ray revealed an intertrochanteric fracture on the right side. The rest of the physical examination was negative.

Laboratory work revealed white blood cells, 9,600; red blood cells, 4.6 million; hemoglobin, 88 per cent; urine, negative. During the course in the hospital the patient was put in Buck's extension. He developed an ulceration over the medial malleolus on the right side two and one-half weeks after admission. He was treated with gentian violet from March 16th to March 26, 1945, without improvement. On March 26th to April 22, 1945, pooled red cells in K-Y jelly were applied every second day. In the six days there was some subsidence in the swelling and pain but the healing was minimal. On April 22nd the placental blood mass was applied. This caused marked relief in the amount of pain suffered by the patient and also in six days there was noticeable healing and proliferation of healthy granulation tissue. For the first six days the mass was applied daily and from April 28th to May 14, 1945, it was applied every three days. The ulcer healed in three weeks.

CASE II. B. D., aged seventy-two, was admitted with a history of falling down four stairs on the left side of the body. The patient was unable to raise herself. She complained of pain over the left hip.

Examination revealed an elderly female moaning in pain. The left foot was everted. There was marked tenderness over the greater trochanter. Inability to abduct or adduct the leg was present. The other essential findings were generalized arteriosclerosis and a blood pressure of 174/100. X-ray revealed a fractured neck of the femur in a good position.

Laboratory work revealed hemoglobin, 84 per cent; red blood cells, 4.2 million; white blood cells, 6,800; total proteins, 6.8; albumin, 4.2; globulin, 2.6; urine, negative.

During the course in the hospital the patient was put in Wilkie boots. About three weeks later the patient developed an ulcer over the lateral part of the right heel (the heels of the

cast were cut out when the cast was applied). The placental mass was applied to the ulcer every second day from August 16, 1945. On September 19, 1945, the area was healed. This patient had immediate relief of pain almost instantly after the first application of the placental mass.

CASE III. E. B., aged fifty-six, was admitted with a history of falling from a chair in her own home. She fell on her left side. There was instant pain in the left hip. The patient was not able to raise herself from the ground.

Examination revealed pain over the greater trochanter and inability to flex the hip on the abdomen. There was pain on passive motion; abduction and adduction of the hip was nil. Other essential findings were a 4 plus Wassermann and subcutaneous hematoma of the left buttock.

Laboratory work revealed red blood cells, 4.4 million; white blood cells, 7,200; urine, negative; total proteins, 6.2; albumin, 3.6; globulin, 2.6.

During the course in the hospital the patient was put in Buck's extension when the x-ray revealed an intertrochanteric fracture with avulsion of the greater trochanter. After one week of traction she developed a decubitus ulcer. Amigen was given intravenously and the placental mass was applied every second day from June 16th to July 14, 1945. After the second application the patient stopped groaning and exclaimed in an appreciative manner concerning the relief obtained. Edema and inflammation disappeared at the end of the third day. The ulcer healed in a month.

CASE IV. V. F., aged sixty-nine, was admitted with a history of falling on his left side while walking. He immediately complained of pain in his left hip.

Examination revealed the left foot to be everted and tenderness over the greater trochanter. There was marked limitation of flexion of the hip with practically no adduction or abduction of the hip present. The other essential findings were generalized arteriosclerosis, blood pressure of 174/100, a systolic over the apex that was not transmitted and extrasystoles.

Laboratory work revealed the following: urine, negative; white blood cells, 8,600; red blood cells, 4.4 million; hemoglobin, 90 per cent; total proteins, 6.8; albumin, 4.0; globulin, 2.8.

The patient was put in Buck's extension. About two weeks later he developed a decubitus ulcer. This was treated with placental blood mass every second day from May 17, 1945. There was immediate relief of pain. Edema and inflammation subsided in two days and the ulcer was completely healed by June 30, 1945.

On June 12th the patient developed an ulcer on the heel of his right foot. The medial part of the ulcer was treated with ordinary red cell mass and the outer with placental blood mass. It was noted that the pain in the area of the placental mass seemed to subside much sooner. The pain subsided in the outer area at the second application while the medial area still was inflamed and the patient still complained of pain. On July 2nd the outer area was healed and the medial area treated with the ordinary blood mass was still granulating.

CASE V. R. K., aged seventy-two, was admitted with the history of being hit by a car. There was pain on motion of the right hip joint. The foot on the effected side was everted. Abduction and adduction of the leg was nil. The rest of the physical examination was negative.

Laboratory work revealed the following: urine, negative; hemoglobin, 82 per cent; red blood cells, 4.0 million; white blood cells, 7,600; total proteins, 5.8; albumin, 3.2; globulin, 2.6.

While in the hospital, the patient had a Smith-Petersen nailing done after two transfusions of 500 cc. each. The proteins at the time of operation were 6.6, albumin, 4.4 and globulin, 2.2. About two weeks after the nailing the patient developed a decubitus ulcer. This was treated for the first week with gentian violet without improvement. After that placental blood mass was applied every second day. The ulcer healed in twenty-two days after the first application.

CASE VI. J. K., aged sixty-eight, was admitted with the history of diabetes for the past ten years. He had had an ulcer on the right lower tibia for three months for which he was treated in the clinic without relief. The ulcer was painful and the pain radiated up the entire leg.

Examination revealed an ulcer the size of a silver dollar about 2 inches above the medial malleolus, deep and necrotic in character. The other essential findings were blood pressure of 184/104 and a systolic murmur over the apex

that was not transmitted. Sclerosis of radials and brachial arteries was present. Posterior tibials and dorsalis pedis were palpable.

Laboratory work revealed the following: urine, 2 plus sugar; acetone, negative; red blood cells, 4.6 million; white blood cells, 9,200; total proteins, 6.4; albumin, 3.0; globulin, 2.4; electrocardiogram, negative; x-ray of the chest, negative; blood sugar, 290.

During the course in the hospital the patient was put on 20 units of protamine zinc insulin, packs of penicillin of 500 u./cc. were applied locally and 20,000 units every three hours administered intramuscularly were also given. There was no abatement of the symptoms and the pain was as marked as before. No healing of the ulcer resulted; the treatment was continued for two weeks. At the end of that time the placental blood mass was applied. The results were extremely gratifying. The pain was alleviated almost immediately. In six days there was a reduction of edema and inflammation; in ten days the base looked healthy; in thirty-nine days the ulcer was healed. All this occurred even though the patient fell out of bed and suffered a fracture of the neck of the femur on the same side for which he had a Smith-Petersen nailing.

CASE VII. A. S., aged fifty-six, was admitted with a history of pain in the right groin for two days. She noticed a "lump" at that time. The lump could be pushed back but during the previous six hours she was not able to do so. During this interval she developed nausea and vomiting. She did not have any bowel movements for twenty-four hours nor the passage of flatus.

Examination revealed a middle-aged woman, vomiting and suffering pain. There was a hernia above Poupart's ligament on the right side that was irreducible and painful. No distention was noticed.

Laboratory work revealed the following: urine, negative; red blood cells, 4.8 million; white blood cells, 9,600 with 82 per cent polymorphonuclears.

During the course in the hospital a Levine tube was passed and intravenous fluids of 5 per cent glucose were started. The patient was taken to the operating room where a herniorrhaphy was done for an incarcerated hernia. The patient did well until the tenth day when she developed a decubitus ulcer and abscess. The abscess was opened; the



ulcer was packed with the placental mass and in three weeks the entire area was healed.

CASE VIII. I. A., aged sixty-one, was admitted with an ulceration about 2 inches above the medial malleolus on the right leg of six week's duration. He was treated by his local doctor with Ace bandages after ligation of his saphenous vein, Unna boot and castor oil dressings without relief.

Examination revealed an ulceration about 2½ inches in diameter, a necrotic base and irregular edges. There was a scar in the right groin where previous saphenous ligation was done. There were no tortuous veins visible. The rest of the examination was negative.

Laboratory work revealed the following: urine, negative; red blood cells, 5.1 million; white blood cells, 7,600 with 74 per cent polymorphonuclears; total proteins, 6.6; albumin, 4.4; globulin, 2.2; glucose, 94.

During the course in the hospital placental blood mass was applied twice every day. After the first six applications the base showed healthy granulation tissue; in six weeks the entire ulcer was healed.

CASE IX. S. C., aged sixty-one, was admitted with an ulceration over the right ankle of one month's duration, accompanied with pain and swelling. The patient had tried various home remedies without relief. There was no past history of diabetes, syphilis or tuberculosis. The only essential findings were sclerosis of the radials and brachial arteries, blood pressure of 164/92 and a soft blowing systolic murmur at the apex. The ulceration was about 2 inches in diameter, with a clean base and sharp edges with marked inflammation around the entire wound. The dorsalis pedis and posterior tibials were palpable.

Laboratory work revealed the following: Wassermann, negative; blood sugar, 84; white blood cells, 7,500 with 65 per cent polymorphonuclears; red blood cells, 4.6 million; hemoglobin, 88 per cent; total proteins, 6.2; albumin, 4.2; globulin, 2.

The placental mass was applied every day. On the second day the pain was gone. On the sixth day the inflammation disappeared and the wound was greatly improved. The patient, seeing the rapid healing of the ulcer, went home and returned to the clinic for treatment. The ulcer formed a firm scab in two weeks. When this was removed, there was active bleeding. The entire ulcer healed in three weeks.

CASE X. E. F., aged seventy-one, was admitted with an ulcer over the left ankle of six weeks' duration. She had been put on the regimen of boric acid ointment, Ace bandages, gentian violet but there was no appreciable improvement of the condition. There was no past history of syphilis or tuberculosis.

Examination revealed an indolent ulceration about 2 inches in diameter, with marked edema and inflammation around the wound site. There was marked tortuosity of the greater and lesser saphenous veins. Trendelenburg and Perthes tests were negative. The dorsalis pedis was not palpable on the affected leg but the posterior tibial was palpable. Oscillometric readings were 12 to 13.5 on the left leg. The rest of the physical examination was negative.

Laboratory work revealed the following: urine, negative; red blood cells, 4.6 million; white blood cells, 6,800 with 72 per cent polymorphonuclears; electrocardiogram, negative; blood sugar, 74.

During the course in the hospital the patient refused saphenous vein ligation. The placental mass was applied once a day. The pain was relieved in one day and the swelling and inflammation were gone on the second day. The patient felt so much improved that she signed a release and went home before the ulcer was healed. A month later the patient was readmitted. She received the same therapy and in three weeks the ulcer was practically healed and had a firm, gray-pink scab over the surface.

#### CONCLUSIONS

1. A comparative study of the pooled red cell mass and the placental mass demonstrates conclusively that the action of the latter is more potent in its healing properties.

2. The patients on whom the preparation has been used were not selected. They were mostly people of advanced age who had the wounds of varying periods of time. On all of these patients the characteristic of the substance was its marvelous pain alleviating property.

3. Penicillin was tried in one patient both locally and parenterally with signal failure. The substance we used proved to be superior.

4. The improvement of the placental mass over red cells may be due perhaps

to a greater amount of "growth hormone" discussed in the literature, and also perhaps due to a greater amount of the steroids, glycogen and vitamin C in placental tissue.

5. No reaction was found to be caused by the application of placental blood.

6. In one case it was used to pack an abscess cavity which is an acute lesion, good results were obtained.

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# COMPARISON OF CRASH INJURIES IN MAN AND IN LABORATORY ANIMALS\*

ROBERT F. RUSHMER, M.D.  
*Seattle, Washington*

AND

GEORGE M. HASS, M.D.  
*Chicago, Illinois*

**D**URING the past two years four series of experiments have been conducted to study the effects of abrupt deceleration on laboratory animals. Obviously, the results of these experiments have practical value only if it is reasonable to assume that the mechanisms by which the injuries were produced were the same in the experimental animals as they are in man during aircraft accidents. An indication of the validity of this assumption can be obtained by comparing the effects of these mechanisms as they become manifest in the production of pathologic lesions. For this reason it was deemed advisable to compare observations made on humans coming to autopsy following aircraft accidents with the lesions produced in experiments conducted on cats, rabbits and mice.

## METHODS

The source of the data on the internal injuries in humans during aircraft accidents was a series of twenty-four postmortem examinations which had been collected by one of us (G. M. H.). From descriptions of the accidents, statements of witnesses and the types of aircraft involved twenty-one cases were selected in which the victim apparently had been seated facing forward at the moment of impact of the aircraft with the ground. In the eighteen accidents which were studied, the following types of aircraft were involved: liaison, two; primary trainers, three; basic trainers, two; twin-engine advanced trainers, four; single-engine transitional trainers, three and twin-engine transitional trainers, four. All the victims of these crashes apparently had been killed instantly, with the exception of six cases involved in crash landings occurring

at approximately the stalling speed of the aircraft (ranging between 50 to 90 miles per hour). The remainder of the crashes occurred after the aircraft had fallen out of control from various heights so that the velocity at impact was unknown. Autopsies had been performed on each victim and, of these, eight had been conducted by one of us (G. M. H.), the remainder being obtained from various stations in the Central Flying Training Command. Some of the pathologic findings in these cases have been described previously.<sup>1-3</sup>

A group of nine victims were known to have survived long enough to reach a hospital. The duration of survival ranged from 1.5 to 80 hours. Six of these were cases involved in low velocity accidents and were also included in the preceding group. The three additional cases included a glider pilot and two flight engineers standing on the flight deck of the airplane at the moment of impact. This group of nine cases was considered separately because it consists of cases approaching the borderline between fatal and survivable injuries.

Two series of experiments have been conducted using cats under nembutal anesthesia. In the first series twenty-three animals were restrained in carts by means of web straps which were similar to the seat belt and shoulder harness found in aircraft. (Fig. 1.) The cart was allowed to fall from vertical distances ranging between 18 and 20 feet and was decelerated by means of a hydraulic shock absorber, sponge rubber pads (1.5 inches thick) or felt pads (0.25 inch thick). The decelerative distance ranged from 6.5 inches to less than 0.25 inch. In fourteen experiments the seat belt was secured, but the shoulder straps were

\* From the Department of Medicine, Army Air Forces School of Aviation Medicine Randolph Field, Texas.

fastened in such a way that they became disengaged on impact allowing the trunk of the animal to swing forward against an obstruction designed to simulate the instrument panel of an aircraft. In five experiments the seat belt and shoulder harness or the entire seat assembly were allowed to disengage on impact. These experiments were conducted for the purpose of obtaining high speed motion pictures (3,600 frames per second) during the deceleration to allow visualization of the distortion and the points of contact of the animal.<sup>4</sup> By analyzing successive frames on the motion picture film, the terminal velocity was found to range between 34.0 and 36.0 feet per second (23.2 to 24.4 miles per hour).

In the second series of experiments, anesthetized cats were immobilized in the supine position on heavy steel carts by embedding them in plaster of Paris. The velocity at impact was about 35 feet per second (24 miles per hour). Forty animals were divided into four groups of ten animals each. The distance of deceleration for each group was provided by sets of paraffin blocks of four types so that the magnitude of the peak force averaged 140.9 g, 267.5 g, 626.1 g and 1045.2 g, respectively. The pattern of decelerative force was recorded by means of a strain gauge accelerometer.\* This study has been reported elsewhere in detail.<sup>5</sup>

In a third study twenty-two preliminary experiments were conducted on rabbits under nembutal anesthesia.<sup>6</sup> They were exposed to decelerative force while mounted in one of four different positions on a simple cart: (1) six animals were facing forward and fastened to the rear panel by webbed straps simulating a seat belt and shoulder harness; (2) four animals were restrained in the same position by straps which were allowed to disengage at impact; (3) six animals were restrained facing forward with their ventral surfaces resting on the back of the forward panel and (4) six animals faced backward with their

dorsal surfaces resting on the forward panel. The cart was allowed to descend a track 20 feet long inclined at an angle of 52 degrees from the horizontal. Deceleration occurred when the cart made contact with a rigid bar mounted near the lower end of the track. The silhouette of the leading edge of the cart was photographed by means of a high speed continuously recording 35 mm. camera. The velocity of the cart at impact was calculated from measurements of the rate of movement of the silhouette recorded on the film, and ranged between 26 and 30 feet per second (18 to 20 miles per hour). The distance of deceleration was between 1 and 2 inches.

In the fourth series of experiments<sup>7</sup> thirty-three mice were exposed to very abrupt deceleration while fastened in the supine position to a platform mounted on the top of a heavy steel cylinder. After a free fall of seven feet the lower end of the cylinder made contact with a piece of boiler plate (weight 83 pounds) which was separated from a cement foundation by a layer of felt 0.75 inch thick. The velocity at impact was approximately 19 feet per second (13 miles per hour) and the distance of deceleration of the carriage was approximately 0.06 inch.

## RESULTS

It is apparent that the conditions obtaining during aircraft accidents cannot be reproduced in experiments on animals. The lesions in animals might have little in common with those encountered in humans owing to obvious differences in the following factors: velocity at impact, distance of deceleration, attitude of the body with respect to the direction of action of force, type of restraint, character of surfaces with which the body made contact, the amount of muscular tension at the moment of impact, body weight and the anatomy and relative structural strength of the various organs and tissues. However, if the same mechanisms are involved in the production of injuries in aircraft accidents and under the experimental conditions, the location and nature of the traumatic lesions should

\* Designed and constructed by the Statham Laboratories, Los Angeles, Calif.

vary only in incidence and severity. It should be emphasized that the internal injuries observed in some of the personnel who died instantaneously in aircraft accidents were far more extensive than those produced in any of the experimental ani-

mals. However, more extensive trauma was encountered in certain cases among each type of experimental animal than was reported in the nine human victims who survived more than one hour.

To demonstrate the similarity in ap-

TABLE I

TYPES OF INTERNAL INJURIES PRODUCED BY AIRCRAFT ACCIDENTS AND EXPERIMENTAL ABRUPT DECELERATION

No. of Cases	Humans		Cats		Rabbits, 22 Cases	Mice, Supine 33 Cases
	Seated 21 Cases	Surviving > 1 Hr. 9 Cases	Seated 23 Cases	Supine 40 Cases		
Brain—total number.....	14	5	3	2	6	21
Hemorrhage.....	7	5	3	2	6	21
Laceration.....	2	0	0	0	0	0
Evisceration.....	5	0	0	0	0	0
Heart—total number.....	8	1	0	0	0	0
Hemorrhage into muscle.....	2	1	0	0	0	0
Ruptured auricles.....	2	0	0	0	0	0
Ruptured ventricles.....	2	0	0	0	0	0
Rupture of both.....	2	0	0	0	0	0
Pericardium—total number.....	6	2	0	3	0	0
Laceration.....	5	0	0	0	0	0
Hemorrhage.....	1	2	0	3	0	0
Aorta—total number.....	5	0	0	0	0	0
Lungs—total number.....	18	9	21	30	21	29
Hemorrhage.....	18	9	21	28	21	26
Emphysema.....	11	4	1	8	8	3
Lacerations.....	11	2	0	1	2	2
Lacerations from rib frac.....	3	0	0	0	3	0
Diaphragm—total number.....	8	1	1	4	1	0
Hemorrhage.....	2	1	1	2	0	0
Laceration.....	2	0	0	1	1	0
Herniation.....	4	0	0	1	0	0
Liver—total number.....	10	0	5	10	15	13
Laceration.....	10	0	5	10	15	13
Spleen—total number.....	10	1	1	15	0	2
Laceration.....	10	1	1	15	0	2
Kidneys—total number.....	10	4	2	1	3	2
Perirenal hemorrhage.....	5	2	0	0	1	2
Hemorrhage into kidney.....	1	1	2	1	0	0
Laceration.....	3	1	0	0	1	0
Rupture of renal vessels.....	2	1	1	0	1	0
Intestines—total number.....	5	2	4	1	10	5
Hemorrhage in wall.....	1	1	4	1	6	4
Rupture of gut.....	5	1	1	0	4	1
Mesentery—total number.....	5	2	3	1	3	9
Hemorrhage into mesentery.....	4	1	3	1	1	9
Tears of mesentery.....	5	1	0	0	2	0
Pancreas—total number.....	2	0	1	4	0	0
Hemorrhage.....	2	0	1	4	0	0
Bladder—total number.....	1	0	13	0	0	0
Hemorrhage.....	1	0	12	0	0	0
Rupture.....	0	0	1	0	0	0
Died spontaneously.....	21	9	6	5	13	20

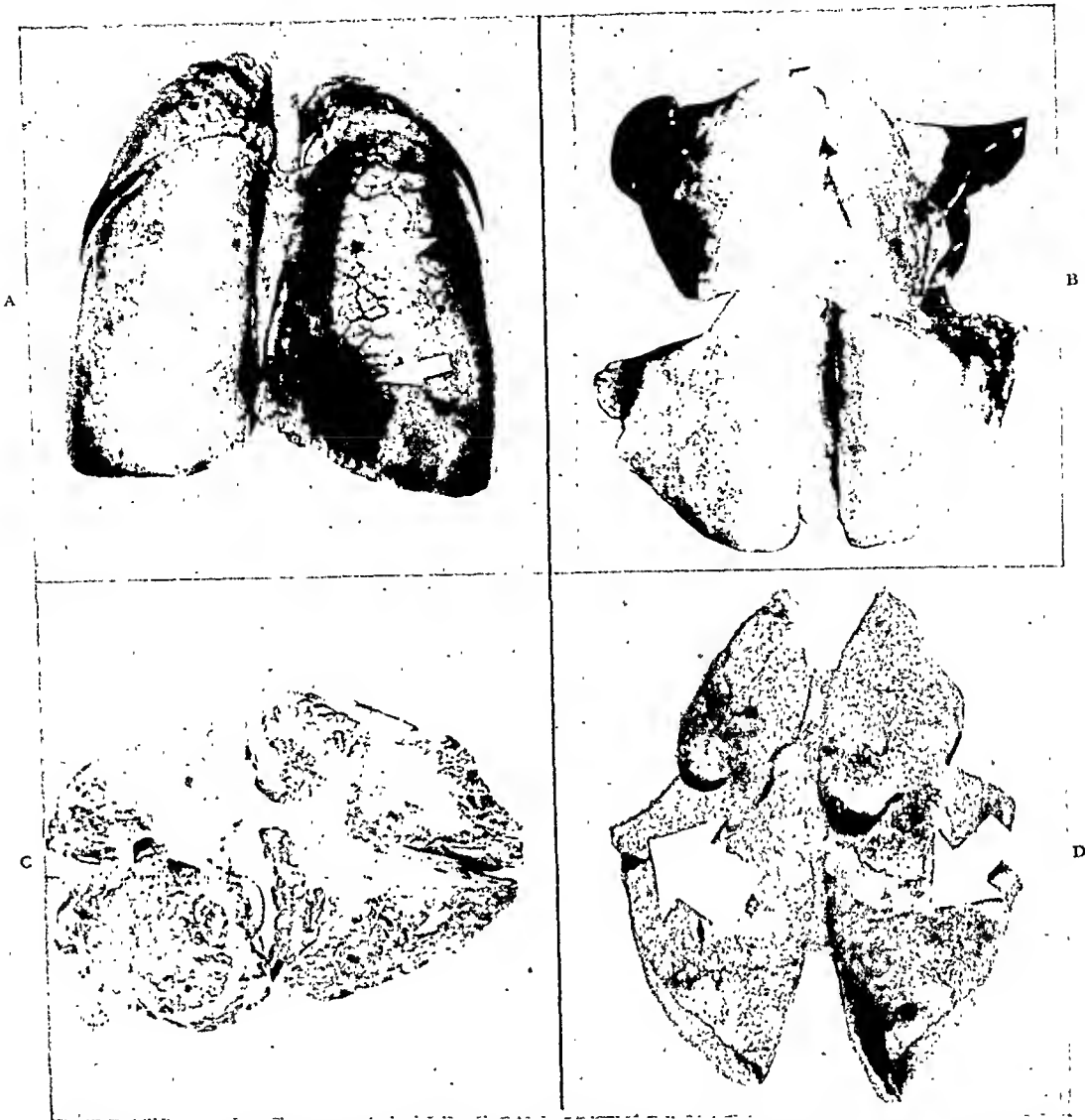


FIG. 1. A to D, photographs illustrating the similarity between parenchymatous hemorrhage and traumatic emphysema found in man and cats exposed to large decelerative forces.

pearance between the lesions encountered in victims of aircraft accidents and in one species of experimental animals, a series of photographs have been selected. The cat was chosen for this comparison primarily because photographs were not obtained routinely in the preliminary experiments on rabbits and mice. The various types of lesions observed during examination of the brain, and viscera within the thorax and abdomen, have been tabulated. (Table 1.)

Cerebral hemorrhage was frequently encountered in man and occasionally observed in each group of experimental animals. (Table 1.) In two human cases depressed fractures of the skull were associ-

ated with cerebral lacerations and, in five additional cases, large defects in the skull were produced, resulting in partial evisceration of the brain. Comparable degrees of injury to the head have not been observed in any of the experimental animals.

Hemorrhages into the lung parenchyma have been induced experimentally which are similar to those so frequently encountered in man with respect to appearance, severity and incidence. (Fig. 1.) Traumatic emphysema of the lungs was similar in appearance and anatomical distribution but was not nearly so frequently observed. (Table 1.) Lacerations of the lungs were rare in the experimental animals.

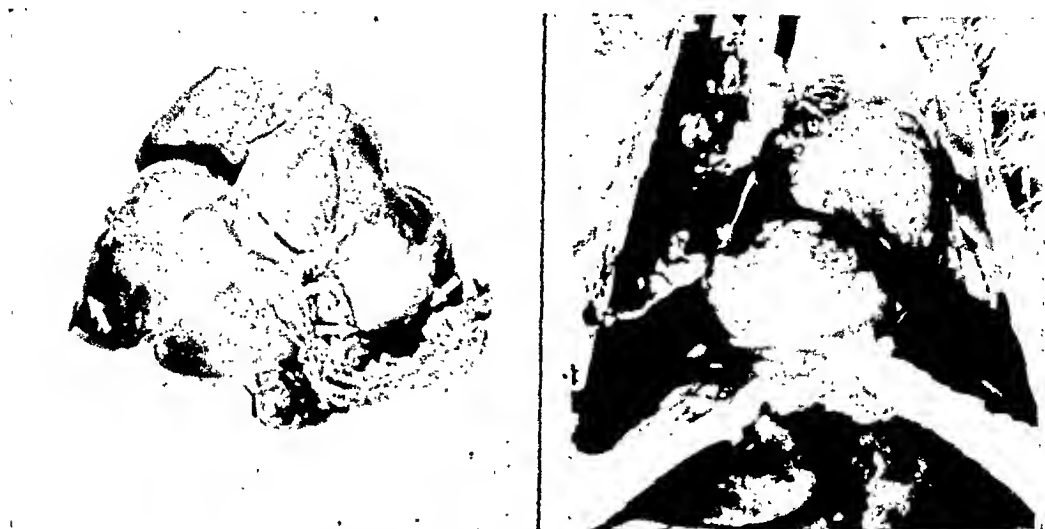


FIG. 2. Laceration and herniation of the diaphragm indicate that the abdominal organs are propelled violently in the cephalad direction in some phase of deceleration.

Extensive injuries to the heart and great vessels occurred in nine human cases involved in aircraft accidents. These included rupture of the walls of the auricles and ventricles associated with lacerations of the pericardium and in five cases with partial or complete rupture of the wall of the aorta. Such injuries were not encountered in the experiments of any of the animals. Tearing of three intercostal arteries from the aorta occurred in one rabbit.

The nature of the lesions in the diaphragm lends support to the concept that violent displacement of intra-abdominal organs may occur during deceleration. Hemorrhage and laceration of the diaphragm occurred occasionally in both man and animal. (Table 1.) Portions of one or more of the following were herniated through the diaphragm into the thorax in four human cases: liver, two; spleen, two; right kidney, two and stomach, one. (Fig. 2.) In one cat experiment, part of the right lobe of the liver was forced into the pericardial sac, displacing the heart cephalad. (Fig. 2.)

Examples of superficial lacerations or rupture of the liver (Table 1) were encountered in humans and in each type of laboratory animal. Among the human cases surviving more than one hour no pathologic lesions in the liver were reported. The most common anatomical locations of the lacera-

tions in the liver were on the diaphragmatic and inferior aspects. (Fig. 3.)

Hemorrhage and rupture of the walls of the gastrointestinal tract were encountered in man and in each species of animal. Hemorrhage into the mesentery was produced in man and in each type of experimental animal. Laceration of the mesentery occurred in six human cases but was found only in two rabbits.

Laceration of the spleen occurred in every group with one exception. Among the rabbits the spleen was intact even in cases with extensive injury elsewhere. Elongated subcapsular ecchymoses at the level of the right lower rib margin were frequently observed in the experiments on cats but were not severe enough to be included in the results. Complete transverse rupture of the spleen was the only gross evidence of injury in one cat. (Fig. 4.) The example of complete rupture of the spleen in man (Fig. 4) was associated with extensive traumatic lesions elsewhere.

In man, traumatic lesions involving the kidney included interstitial hemorrhage, rupture, laceration of a major vessel in the pedicle and perirenal hemorrhage where the source of the extravasation was not apparent. Signs of renal damage were uncommon in the experimental animals but examples of each type of injury described in humans were encountered among the ex-



FIG. 3. Superficial lacerations of the liver are most commonly seen on the diaphragmatic aspect to the right of the midline. As seen here they may occur on both surfaces of the same liver. Such lacerations may be the result of distortion or bending of this solid organ.

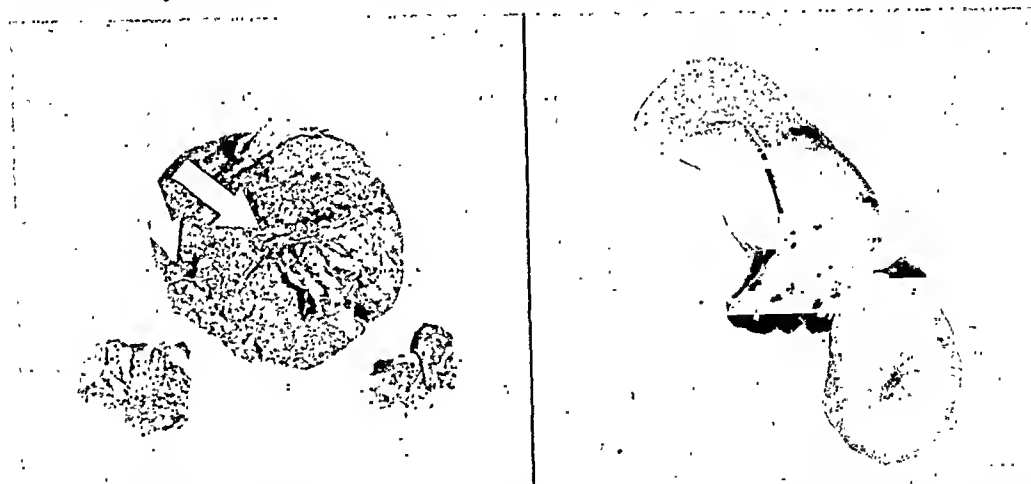


FIG. 4. Lacerations of the spleen resemble those of the liver. The ruptured spleen in the cat was the only demonstrable injury found in the animal.

perimental animals. However, all the lesions described were not observed in any one species of animal.

Hemorrhage or laceration of the adrenal glands was reported in four human cases. Unfortunately in the postmortem examinations of the experimental animals no particular effort was made to examine the adrenal glands routinely, so no comparative figures on the incidence or severity of injury to these organs are available.

The pancreas was not a common site of traumatic lesions. In a few cases extrava-

sation of blood in various portions of the gland was encountered, but this was limited and apparently of little significance.

Using a simulated cockpit in which a webbed strap passed over the lower abdomen, retroperitoneal hemorrhages at the neck of the urinary bladder occurred frequently only in the experiments on cats. In one such experiment, the bladder was torn completely across at the neck and was found within the peritoneal cavity.

Fractures of the skull, ribs and extremities were extremely common in the series of



human cases and very rare among the experimental animals.

#### COMMENTS

In spite of variability and important differences in the manner in which decelerative forces were applied, most of the pathologic lesions found in experimental animals were similar to those described at postmortem examination of humans who had been involved in aircraft accidents. In general, the severity of the injuries was much greater in the humans than in the laboratory animals. From a physical point of view it seems likely that this was due largely to the fact that most of the aircraft were traveling at high velocity at the moment of impact.

In general, a deceleration which produces large forces is over so quickly that it defies visualization. For example, if a constant decelerative force of 100 g's is applied to an object traveling 110 miles per hour, the deceleration is complete within 0.05 second. For this reason it seems unwise to devise theories designed to explain the production of internal injuries in the absence of evidence obtained in controlled experiments. The present series of comparisons strongly suggests that the mechanisms by which injuries are produced during abrupt deceleration of animals are similar to those acting in man during crashes. This indicates that experiments on laboratory animals can lead to important advances in our knowledge of the physical factors involved in the production of traumatic injury. Whether information obtained concerning the amount of force which can be survived by animals can be applied to the problems of adequate stressing of aircraft is still open to question.

#### SUMMARY AND CONCLUSIONS

1. A comparison is made of the internal injuries encountered during postmortem examination of flying personnel killed in aircraft accidents with the pathologic le-

sions produced by abrupt deceleration of three species of laboratory animals: cats, rabbits and mice.

2. In spite of many differences in the conditions obtaining during the deceleration, the lungs revealed gross pathologic changes in more than 75 per cent of both humans and experimental animals.

3. In general, the types of lesions in the lungs, liver, spleen, diaphragm, kidneys, gastrointestinal tract and pancreas were similar in man and laboratory animal. The incidence and severity of the lesions were considerably greater in human victims who died instantly. Extensive trauma to the brain, heart and great vessels was not observed in the experimental animals.

4. These findings indicate that direct experimentation on laboratory animals can be a valuable adjunct in the study of the mechanisms of production of internal injuries and possibly also in designing methods of protection against large decelerative forces.

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\* Army Air Forces School of Aviation Medicine, Randolph Field, Texas.

# SHOCK CAUSED BY EXTREMITY WOUNDS

ROBERT BIRCHALL, M. D.

*New Orleans, Louisiana*

DURING the first eight months of the campaigns through France and Belgium the second Evacuation Hospital treated 1,156 patients for shock that complicated extremity wounds. Most of these patients responded well to the conventional treatment of adequate fluid replacement, as demonstrated by a mortality rate of 4.4 per cent as opposed to 12.6 per cent for all patients treated on the shock ward. However, sixty-five patients with extremity wounds either failed to recover as expected or actually became worse during treatment. In this group chance of survival seemed to diminish as fluid replacement was prolonged and surgery delayed. Treatment as judged by a mortality rate of 37.2 per cent was ineffective. Since this group of patients, although numerically small, accounted for 47 per cent of the total mortality, further investigation seemed warranted in an attempt to determine those factors which complicated shock and to establish criteria for their early recognition and management.

For this purpose the records kept on all patients admitted to the shock ward were examined. Data were recorded on a definite chart which accompanied the patient at all times. Proper entries were made by competent observers at least every thirty minutes and more often during surgery. Subsequently, this record was supplemented by an abstract of the patient's initial clinical condition, course, operative findings and final disposition. An autopsy was performed on each fatality and the findings added to this record, regardless of the cause of death or the postoperative day on which it occurred.

Analysis of the 1,156 shock records indicated that consideration of the type of injury, clinical picture and response to treatment divided shock associated with

extremity wounds into three groups: (1) shock due to blood loss; (2) shock associated with gas gangrene and (3) shock complicated by an unknown factor.

## SHOCK DUE TO BLOOD LOSS

Nine hundred fifty-four or 94.4 per cent of those patients treated for shock associated with extremity wounds suffered primarily from the loss of whole blood.<sup>3</sup> The clinical picture plus the uniformly excellent response to the rapid replacement of whole blood constitute the basis for the separation of this group.

These patients exhibited blood soaked clothing, pallor, cold extremities and often imperceptible blood pressure and pulse. Pain was unusual, thirst invariable and often pathetic. Although they were usually conscious, their apathy and detachment made it difficult to maintain rapport. When necessary, cannulation of a vein could be performed without local anesthesia.

This type of shock was considered a medical emergency and every effort was made to "reverse" the shock immediately on admission. In few other medical or surgical conditions is the time factor of such prime importance. Of equal therapeutic importance is the realization that vasoconstriction can maintain a normal blood pressure in the presence of decreased blood volume; it is therefore not wise to wait for "decompensation" and a marked fall in blood pressure before instituting shock therapy.

Treatment was confined to the rapid replacement of whole blood, prevention of further blood loss, correction of dehydration and immobilization of poorly splinted fractures. The response to treatment was so excellent that after the first 500 to 1,000 cc. of whole blood the blood pressure, pulse and entire appearance of these patients

showed a marked improvement. Hemocentration was rarely seen and easily combatted.

Difficulty in preoperative treatment was encountered only in those nine patients who conformed with the clinical picture of "irreversible shock from hemorrhage." These had laceration of one or more major vessels, coma, gasping respiration and imperceptible blood pressure and pulse. The rapid introduction of whole blood was without demonstrable effect; pulmonary edema supervened and all died soon after admission.

#### SHOCK ASSOCIATED WITH GAS GANGRENE

Most patients with gas gangrene infection will, if permitted sufficient time, exhibit characteristic low grade fever with disproportionate tachycardia, clouding of the sensorium and excessive pain in the extremity. When these are combined with obviously impaired blood supply to the involved part, superficial discoloration and crepitation about the margins of the wounds and an odor more sweet than that usually produced by necrotic muscle, the diagnosis is obvious. To wait for a more definite diagnosis is to court disaster.

Forty of our patients at operation or autopsy presented conclusive evidence of gas gangrene infection. The diagnosis was established by the presence of gas and the appearance of the muscle at operation or autopsy. Cultures were not done, and neither x-ray evidence of gas nor the results of muscle biopsy were considered in establishing the diagnosis.<sup>6</sup> Nineteen of these patients died; eleven deaths were attributed to gas gangrene toxemia and three to the administration of gas gangrene antitoxin. As our experience widened it became increasingly apparent that the degree of shock in this group was little influenced by fluid replacement. It was a fatal mistake in therapy to delay surgery in order to continue administration of fluid in excess of that which we believed adequate to establish normal hydration. Proper management of these patients,

therefore, depended upon early recognition and rapid preoperative treatment. Although the responsibility for the final diagnosis and treatment of gas gangrene infection rests with the surgeon, the responsibility for the early recognition of this as a factor complicating hematogenic shock must be assumed by the shock team. It was therefore essential to have criteria by which the early presumptive diagnosis could be established. We found it helpful to separate the patients into two clinically distinct groups

*Those with Minimal Toxemia and Little Evidence of Shock.* These patients, seen more often postoperatively, can be recognized by persistent tachycardia and fever, constant pain in a cold extremity and rapidly developing anemia. Confusion and disorientation are often present; restlessness is unusual, the blood pressure is well maintained and dyspnea at rest is not apparent despite the frequent finding of a red blood cell count of 1,000,000 with a hemoglobin of 25 per cent. Because the symptoms and signs need not be striking, the grave danger is procrastination in the vain hope that further surgery can be avoided.

*Those with Overwhelming Toxemia and Severe Shock.* Regardless of the associated blood loss, these patients present the picture of overwhelming toxemia in the presence of severe shock. The restlessness, confusion and disorientation, and the failure of blood pressure to respond to adequate fluid replacement, are in sharp contrast to the general appearance and response to treatment exhibited by patients suffering primarily from blood loss. Tachycardia persists and a gradual deterioration is observed. Fluid replacement will establish normal hydration but has little effect on the blood pressure or the degree of shock; if continued beyond a rational amount, pulmonary edema will ensue.

The presence of this syndrome, in our experience, does not always insure the finding of clinical gas gangrene at operation. In two instances, however, when this

syndrome was present and no evidence of gas gangrene could be found on radical débridement, an amputation, which was subsequently performed on the first post-operative day because of increasing signs of toxemia, did reveal unequivocal evidence of gas gangrene infection. We believe that at the time of the initial débridement these patients illustrated the picture of subclinical gas gangrene.<sup>1</sup> Since early amputation might have eradicated the infection before clinical gas gangrene developed, we believe that all patients who exhibit this syndrome, regardless of the appearance of the wound, must be treated as potential examples of clostridial infection.

Because of their paramount importance, abstracts of the two case histories illustrating the syndrome of sub-clinical gas gangrene are presented at the end of the paper.

*Preoperative Treatment of Patients Suffering from Shock Associated with Gas Gangrene.* This consists primarily in the early recognition that toxemia and not a decrease in the blood volume is protracting the shock. In the presence of gas gangrene infection the picture of "shock" itself constitutes neither a contraindication for surgery nor an excuse for procrastination. The preparation for surgery must be rapid and should be concluded as soon as it is apparent that no further improvement can be expected from fluid replacement. This is limited almost entirely to whole blood, for in addition to the hemorrhage already sustained as a result of the wound, one must consider the possibility that the toxins liberated by the culturally unidentified gas gangrene bacilli may continue to produce hemolysis. A tourniquet should be applied below the level of the anticipated amputation only in the few instances in which the diagnosis and demand for amputation are certain before the wound is explored.

Antitoxin is the logical complement to early radical surgery. Despite negative skin and conjunctival tests, the dilution of 49,500 units of polyvalent antitoxin

(three ampules) in 500 cc. of isotonic saline and slow intravenous infusion, there were three fatal reactions. We believe that in the absence of more convincing proof of its efficacy than at present exists the risk attendant upon the administration of gas gangrene antitoxin is not justified.

Penicillin and sulfadiazine were given to all patients without any apparent beneficial effects.

#### SHOCK COMPLICATED BY AN UNKNOWN FACTOR

Twenty-five patients presented a type of shock which, although not initially severe, failed to respond to fluid therapy. The more common causes of the protraction of shock, such as continuing hemorrhage, unsplinted fractures, gastric dilatation, pneumothorax, established peritonitis, inadequate fluid replacement, etc., were easily excluded. Gas gangrene infection could not be demonstrated at any time in their course. The charts of these twenty-five patients were therefore analyzed.

The most frequent cause of injury (75 per cent of the patients in whom the cause of injury could be determined) was the explosion of a mine. In the typical case this resulted in the traumatic amputation of one foot with extensive muscle and bone damage of the entire lower leg. Often the force of the explosion had not only riddled all layers of the wounds with dirt, clothing and débris but had driven dirt along the fascial planes of the leg and at times stripped the periosteum from the bone.

The pre-shock ward experiences of these patients (duration of wound, hours of exposure, treatment received in the Battalion Aid Station, weather conditions, etc.) were essentially the same as those of the patients who responded to treatment. Their wounds, in general, were of equal severity.

The clinical picture was characterized by the signs of moderately severe shock coupled with confusion, restlessness and pain in the extremity. In no instance did the patient's color, respiration or the tem-

perature of his extremities indicate excessive hemorrhage or grossly inadequate tissue perfusion. The blood pressure, within normal limits on admission in twelve patients, fell progressively despite adequate or, in some cases, excessive treatment with intravenous fluid. There was no evidence of generalized fluid loss,<sup>4</sup> fresh hemorrhage or local swelling which could represent a steady loss of fluid greater than the volume of that being administered.

The twenty patients who survived were, of necessity, subjected to surgery while still in clinical shock. That their blood pressure pulse and general condition returned to normal within the first three or four postoperative hours suggests that surgical intervention removed the factor that was protracting shock.<sup>2,3</sup>

Illustrative case histories are included at the end of the paper.

*Treatment of Patients Whose Shock is Protracted by an Unknown Factor.* Regardless of the nature of the factor that was removed, the preoperative treatment must have for its objective the rapid preparation of the patient for surgery. Delay and prolonged medical management which attempts to overcome a type of shock not dependent on fluid loss is dangerous. The results obtained with surgery in the presence of this type of shock are excellent. We, therefore, established the rule that if shock due to extremity wounds does not improve after a maximum of five hours of adequate administration of fluids and if other causes of the perpetuation of shock have been excluded, surgery is urgent. Morphine, although not constantly required in the treatment of hematogenic shock, was regularly used in these patients and was most effective when given intravenously. The replacement of whole blood and plasma should be rapid. A tourniquet is pre-eminently indicated in those patients whose condition, after thorough preoperative treatment, is still too critical to withstand surgery. Careful selection of these patients is imperative, for amputation is converted not only from a possibility to a

certainty but the level of the amputation is raised. In addition, the ideal location for the tourniquet is difficult to determine; the absorption is presumably from the entire area of necrotic muscle, the extent of which cannot be detected until the muscle bellies are actually exposed at operation.

#### DISCUSSION

In the management of a shock ward in an Evacuation Hospital one of the most important and difficult decisions consists in establishing priority for operation. The constant back-log of soldiers awaiting surgery and the restrictions imposed by the limitation of x-ray and operating room tables implies that, regardless of the duration of the wound or the time of admission, preference must be given to those patients whose life will be most jeopardized by delay.

It was early observed that the vast majority of patients whose shock was due to extremity wounds required surgery less urgently than did those with abdominal, thoraco-abdominal and often chest injuries. It, therefore, became a matter of prime importance immediately to differentiate those few patients with extremity wounds whose chance of survival depended upon prompt surgical care. We found that careful evaluation of the nature and appearance of the wound, the clinical picture, and response to fluid replacement could segregate these cases within the first five hours of preoperative treatment. We believe that surgical priority of this group of patients should be second only to patients in whom either continuing concealed hemorrhage is suspected or who have otherwise insurmountable mechanical impediments to respiration.

Tables I and II summarize the records of the sixty-five patients whose shock did not respond to treatment with intravenous fluids. Table I indicates that the degree of shock as measured by blood pressure on admission and at operation, duration of wounds and preoperative treatment was similar in those patients who lived and

those who died. The length of time devoted to preoperative treatment tended to be shorter in those who survived but was not statistically significant. Table II indicates a significantly lower mortality rate among those in comparable groups who were

that sudden warmth after many hours of exposure to cold might have produced sufficient vasodilatation to increase tissue perfusion and thereby increase the absorption of an unidentified toxin. The progressive fall of blood pressure in spite of

TABLE I

SUMMARY OF THE SIXTY-FIVE PATIENTS WHOSE BLOOD PRESSURE DID NOT RESPOND TO FLUID REPLACEMENT

Group	No. of Patients	Mean Duration of Wounds (in hr.)	Mean Admission Blood Pressure	Mean Preoperative			Mean Blood Pressure at Operation	Mean Duration of Preoperative Treatment (in hr.)
				Blood	Plasma	Saline		
				(in mm.)				
Gas gangrene toxemia, lived.....	13	10.5	72/39	1450	700	1000	98/42	7.4
Gas gangrene toxemia, died.....	16	8.1	82/47	1630	830	900	90/50	12.5
Minimal gas gangrene toxemia, lived.....	8	9.9	98/52	1000	375	1000	140/80	5.1
Minimal gas gangrene toxemia, died.....	3	7	135/65	2500	...	....	110/75	5
Shock complicated by unknown factor, lived.....	5	8	105/64	2000	950	1200	90/55	8
Shock complicated by unknown factor, died.....	20	9	110/70	1500	500	1500	92/50	6

operated upon within the first five hours. Variables such as the severity of the wound, actual degree of shock aside from the determination of blood pressure, lower priority often, of necessity, accorded to prisoners of war, and the occasional prolongation of preoperative treatment because of non-availability of operating room tables, etc., could not be controlled.

The cause of the protraction of shock in the forty patients with proven gas gangrene infection is clear.

The explanation for the protraction of shock in the twenty-five patients whose apparent toxemia could not be clinically differentiated from that due to gas gangrene infection, but in whom no gas gangrene infection could be demonstrated, is not clear. Twelve of these patients exhibited a blood pressure which, although normal on admission, fell progressively despite treatment. This was observed only during the winter months. It seems possible

adequate treatment, plus the fact that this picture was not seen in hematogenic shock, precludes vasodilatation alone as being responsible for this phenomenon. Although the nature of the toxin in this group of patients is not known, it is significant that the wounds, because of the grossly contaminated ischemic muscle, formed an ideal culture medium for anaerobic organisms. This plus the similarity of the clinical picture and response to treatment suggest the possibility that the generally excellent response to radical débridement or amputation was due to the elimination of a clostridial infection which, although capable of producing toxins, was not yet sufficiently well established to produce clinical gas gangrene. Until it becomes possible to determine the actual presence of circulating gas gangrene toxin, it is our belief that patients presenting this type of shock should be treated as if they suffered from infection due to anaerobic organisms.

Table III is included as a statistical survey of all patients suffering from shock due to extremity wounds.

TABLE II  
COMPARISON OF THE EFFECT OF EARLY AND DELAYED OPERATIONS

Operation within First Five Hours after Admission			
Group Diagnosis	No. of Patients	Lived	Died
Gas gangrene toxemia .....	10	8	2
Minimal gas gangrene toxemia..	7	6	1
Shock complicated by unknown factor.....	16	15	1
Total.....	33	29	4

Operation Delayed More Than Five Hours after Admission			
Group Diagnosis	No. of Patients	Lived	Died
Gas gangrene toxemia.....	19	5	14
Minimal gas gangrene toxemia..	4	2	2
Shock complicated by unknown factor.....	9	5	4
Total.....	32	12	20

#### SUMMARY AND CONCLUSIONS

1. Shock associated with extremity wounds usually represents the most gratifying type of shock to treat.

2. Of the 1,156 patients treated for shock associated with extremity wounds, sixty-five failed to respond to ordinary shock therapy. Twenty-four of these patients died accounting for 47 per cent of the total mortality.

3. Analysis of these sixty-five patients indicates that they may be separated into two groups: (1) shock associated with gas gangrene and (2) shock complicated by an unknown factor.

4. The primary therapeutic indication in these patients is rapid preparation for surgery. The rule is suggested that if

patients whose shock complicates extremity wounds do not improve after five hours of adequate fluid replacement and if other

TABLE III  
STATISTICAL SURVEY OF PATIENTS SUFFERING FROM SHOCK DUE TO EXTREMITY WOUNDS

Total number of patients admitted to the shock ward.....	2,000
Mortality*.....	251 or 12.6%
Total number of patients whose shock was due to extremity wounds....	1,156
Mortality.....	51 or 4.4%
Patients whose shock was due to extremity wounds separated into groups:	
1. Shock due to blood loss	
(1) Total number of patients..	1,091
(2) Mortality.....	27 or 2.5%
(a) preoperative.....	9
(b) postoperative.....	18
2. Shock associated with gas gangrene	
(1) Total number of patients†.	40
(2) Mortality.....	19 or 47.5%
(a) preoperative.....	4
(b) postoperative.....	15
3. Shock complicated by an unknown factor	
(1) Total number of patients..	25
(2) Mortality.....	5 or 20%
(a) preoperative.....	2
(b) postoperative.....	3

Cause of Death in Total Extremity Mortality‡	Pre-operative	Post-operative
1. Shock.....	9	11
2. Gas gangrene toxemia.....	2	9
3. Pneumonia.....	0	8
4. Anuria.....	0	3
5. Gas gangrene antitoxin.....	2	1
6. Anesthesia.....	0	2
7. Transfusion reaction.....	1	0
8. Unexplained.....	1	0
9. Blood dyscrasia.....	0	1
10. Pulmonary embolus.....	0	1

\* All patients who entered the shock ward and subsequently died were included in the mortality statistics, regardless of the cause of death or the postoperative day on which it occurred. An autopsy was performed on each fatality.

† The total number of patients with gas gangrene treated in this hospital was sixty-nine, with a mortality of 24 per cent. Only the patients receiving preoperative treatment on the shock ward are included in this report.

‡ The cause of death was taken directly from autopsy reports.

causes for the perpetuation of shock are excluded, immediate surgery is mandatory.

5. The possible relationship of sub-clinical gas gangrene to the "unknown



factor" complicating shock in the second group of patients is discussed.

#### REPRESENTATIVE CASE HISTORIES

*Subclinical Gas Gangrene.* 1. A soldier was admitted because of shock secondary to a penetrating wound of the left thigh, a compound comminuted fracture of the left tibia and a penetrating wound of the left arm. He was confused and restless, with a pulse of 140 and a blood pressure of 80/50. During the first six hours of preoperative treatment, 3,500 cc. of blood and 1,000 cc. of plasma were administered. Since there was little improvement in his general condition, he was sent to the operating room where extensive débridement revealed no evidence of gas gangrene infection. The patient was returned to the shock ward for further therapy. Because he failed to improve in the next thirty-six hours, he was again taken to the operating room where exploration of his wounds now revealed gas gangrene. Under local anesthesia the left leg was amputated and the diagnosis of gas gangrene subsequently confirmed by the pathologist. The patient expired four hours later. Autopsy revealed that local gas gangrene had finally been eradicated.

2. A soldier was admitted with compound comminuted fractures of both tibias and fibulas and a penetrating wound of the right thigh. He was pale and disoriented; his pulse was 120 and his blood pressure 105/60. Despite 2,000 cc. of blood and 2,000 cc. of saline there was a slow deterioration in his general condition. After six hours his pulse was 140 and blood pressure 100/60; his general condition was so poor that surgery was considered inadvisable. Twenty-six hours after admission, still unimproved, he was taken to the operating room where débridement did not reveal gas gangrene infection. His postoperative course was unsatisfactory. By the third day clinical gas gangrene of the left leg was apparent and an amputation performed. The patient died on the following day. Autopsy revealed that although the stump was clean, there was gas gangrene infection in the muscles of the right thigh.

#### *Shock Complicated by an Unknown Factor.*

1. A soldier was admitted to the shock ward several hours after the explosion of a mine from which he sustained a traumatic amputation of his right foot and multiple small penetrating wounds of both legs. His blood pressure on admission was 130/80, with a

pulse of 104. He was confused and restless. Despite treatment his blood pressure fell progressively and his restlessness increased. Five hours later after he had received 2,000 cc. of whole blood and 1,500 cc. of normal saline, his blood pressure was 90/60 and pulse 120. Further fluid replacement was considered inadvisable and the patient was sent to the operating room. During the induction of anesthesia his blood pressure fell to 70/30 and then slowly improved throughout the operation. It had reached 100/60 at the time that surgery was concluded and his blood pressure and pulse were within normal limits three hours after he awakened from the anesthesia. The remaining postoperative course was uneventful.

2. Following the explosion of a mine, a soldier was admitted to the shock ward with a traumatic amputation of the left foot, compound comminuted fractures of the left tibia and fibula and a severed posterior tibial artery. His pulse was 96 and blood pressure 110/60. His general condition, which was that of incipient shock on admission, gradually deteriorated despite treatment. After 2,500 cc. of whole blood and 1,500 cc. of plasma administered over a period of eight hours there was no improvement. Restlessness and confusion increased; his rectal temperature was 101°F. An x-ray film of his chest was within normal limits. He was finally taken to the operating room with a blood pressure of 80/60. This remained unchanged throughout operation but improved rapidly postoperatively and was within normal limits five hours after he awakened from the anesthesia.

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# HEMANGIOMAS OF STRIATED MUSCLE\*

C. FRED GOERINGER, M.D.

Instructor in Orthopedic Surgery, University of Pennsylvania Hospital  
*Philadelphia, Pennsylvania*

A SURVEY of the literature indicates that hemangioma of skeletal muscles can no longer be considered as an unusual lesion. Many such cases have been overlooked during hasty physical examinations. In some instances the patient does not complain of pain although he may have a tumor of considerable size. In other examples there may be no swelling whatsoever and yet manifestations of pain and weakness may exist locally.

According to MacDermott, hemangioma of muscles was first described by Muscatello in 1894 although Liston reported a case in 1843. Davis and Kitlowski described the lesion as a tumor of more or less extensive vascularity due to malformation and proliferation of the pre-existing vessels of the muscle. Popular interest in this subject of hemangiomas can be dated from the three reviews of the subject in 1930 by Davis and Kitlowski, in 1932 by Jenkins and Delaney and more recently in 1944 by Shallow, Eger and Wagner. A total of 335 cases has been collected by these workers.

The first case report is of interest because of its unusual location in the sartorius muscle. Only one other case has been described in which the tumor was confined entirely to that structure, (Fonari). Excision resulted in recovery. Case II represented a problem of diagnosis. No tumor swelling was present on examination.

## CASE REPORTS

CASE I. The patient was a twenty-two year old American soldier born of Chinese parents. There was no history of definite injury. In January, 1943, about one year prior to admission to the hospital, he noticed a swelling of the lower inner aspect of the right thigh. He com-

plained of occasional stiffness in this region. There was no pain or limitation of motion. The swelling became larger in size in cold weather and also toward the end of each day. On examination a soft, cystic-like mass 12 by 7 by 3 cm. deep was found on the inner aspect of the thigh just above the adductor tubercle region. (Fig. 1.) It was attached to the deeper structures but not to the skin. There were no points of tenderness. The tumor did not transilluminate. The swelling was found to be anterior and medial to the inner hamstrings. It was present when the leg was in the dependent position but it disappeared when the leg was elevated. Application of a tourniquet about 4 inches above the site of the tumor did not prevent its disappearance when the leg was raised. The preoperative diagnosis was lymphangioma.

Laboratory and diagnostic findings revealed the following: X-ray findings revealed a soft tissue shadow in the supracondylar region of the medial aspect of the right knee. Kahn test was negative and urine and blood tests were within normal limits. The clotting time, white blood count, red blood count and differential were all normal.

The operation was performed on January 4, 1944. The table was tilted to an angle of about 70 degrees with the patient in a prone position. Local novocain infiltration was satisfactory. A 14 cm. incision was made into the skin and dissection was carried down to the sartorius muscle. The saphenous nerve was isolated and retracted laterally. The gracilis and semitendinosus muscles and tendons were identified. The sartorius muscle was divided at a point about 3 inches superior to the adductor tubercle and the inferior portions of the muscle and tendon were removed. The distal portion of the proximal segment was sutured to the gracilis muscle with interrupted cotton sutures. The wound was closed in layers with fine cotton interrupted sutures. At a point about 1 inch above the adductor tubercle the sartorius muscle was found to be involved by a hemangioma-

\* Read at the meeting of the Philadelphia Orthopedic Club, March 14, 1946.

tous varix-like tumor with dilated venous channels. The tumor was soft in consistency and involved the posteromedial part of the muscle. There was no evidence of scar tissue or hypervascularity.

The pathologic report revealed the following: Microscopically, the section is composed of voluntary muscle fibers within which there is a large cavernous hemangioma. Some of the spaces are filled with erythrocytes. The walls of the vessels are thin, lined by epithelium and show coalescence. There is compression atrophy of the adjacent muscle. There is no inflammatory infiltrate nor evidence of malignancy. The patient was asymptomatic one year postoperatively.

**CASE II.\*** A nineteen year old white female was admitted to the University Hospital on June 7, 1945, because of left calf pain and inability to dorsiflex the left foot. Symptoms began two years prior to admission.

Physical examination revealed the left foot to be in moderate equinus. The foot could not be dorsiflexed to within 45 degrees of a right angle. X-rays of both feet and ankles were negative. Laboratory studies were not remarkable, including white count and urine studies which were negative. Preoperative diagnosis was chronic myositis with adhesions in the lower calf muscles. A local novocain injection caused no immediate relief. Physiotherapeutic measures were without avail. On June 8, 1945, an exploratory incision was made on the posteromedial aspect of the left calf muscle. A small fibrotic tumor with irregular purple areas was removed. A cast was applied from the toes to above the knee with the foot in fixed dorsiflexion.

The pathologic report revealed the following: Grossly, the specimen consists of three pieces of muscle, fat and fibrous tissue. Near the center of the largest and most superficial there is an irregular red, somewhat firm lesion measuring 1.3 by 1.2 cm. The same lesion is seen in the more superficial portion of the deeper tissue. Sections are taken from both portions of tissue. Microscopically, around the periphery there are collections of normal appearing muscle and adipose tissue. Nearer the center there are a number of blood vessels with thick walls. The muscle tissue in this location has undergone partial hyalinization and there is considerable

\* This case history was obtained from the files of the University Hospital, Philadelphia, Pa.

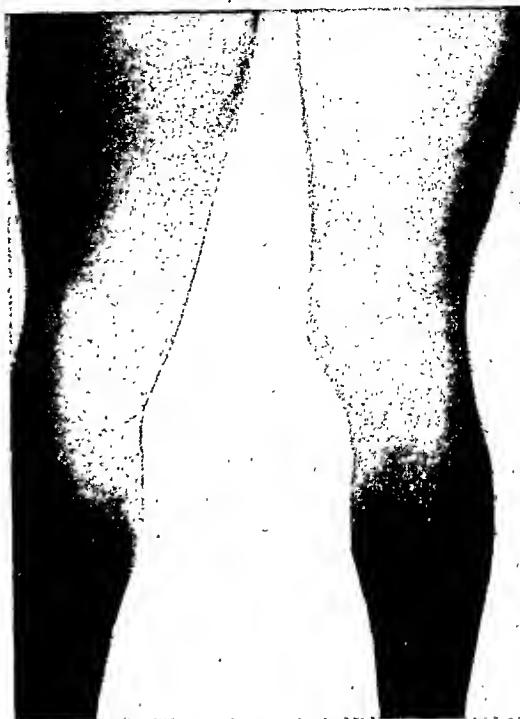


FIG. 1. Preoperative photograph revealing the tumor on the medial aspect of the right popliteal fossa.

collagenous tissue. In addition there are many thin-walled endothelial-lined vessels containing erythrocytes. Much hemosiderin is present. Diagnosis was cavernous hemangioma of calf muscles. (Fig. 2.)

Follow-up on March 11, 1946, revealed that the patient had the same complaints which she had preoperatively. On forced inversion of the left ankle a crepitation sound was elicited. The heel cord is still tight.

**CASE III.** A fifteen year old school girl was admitted to the University of Pennsylvania Hospital on October 6, 1947. A swelling of the inner aspect of the left elbow was noted five years previously. There was no history of injury. On occasion the patient noted that the tumor changed its size but in recent weeks it became increasingly more swollen and painful. Weakness of the forearm developed, particularly when she attempted to pick up heavy objects. There was a cystic, tender swelling measuring 3 by 3 by 1.5 cm. at a point on the upper inner aspect of the left forearm about 2 inches below the inner condyle of the left humerus. (Fig. 3.) No audible or palpable bruit was made out. Elevation of the extremity and application of a tourniquet above the tumor caused a decrease in the size of the mass.

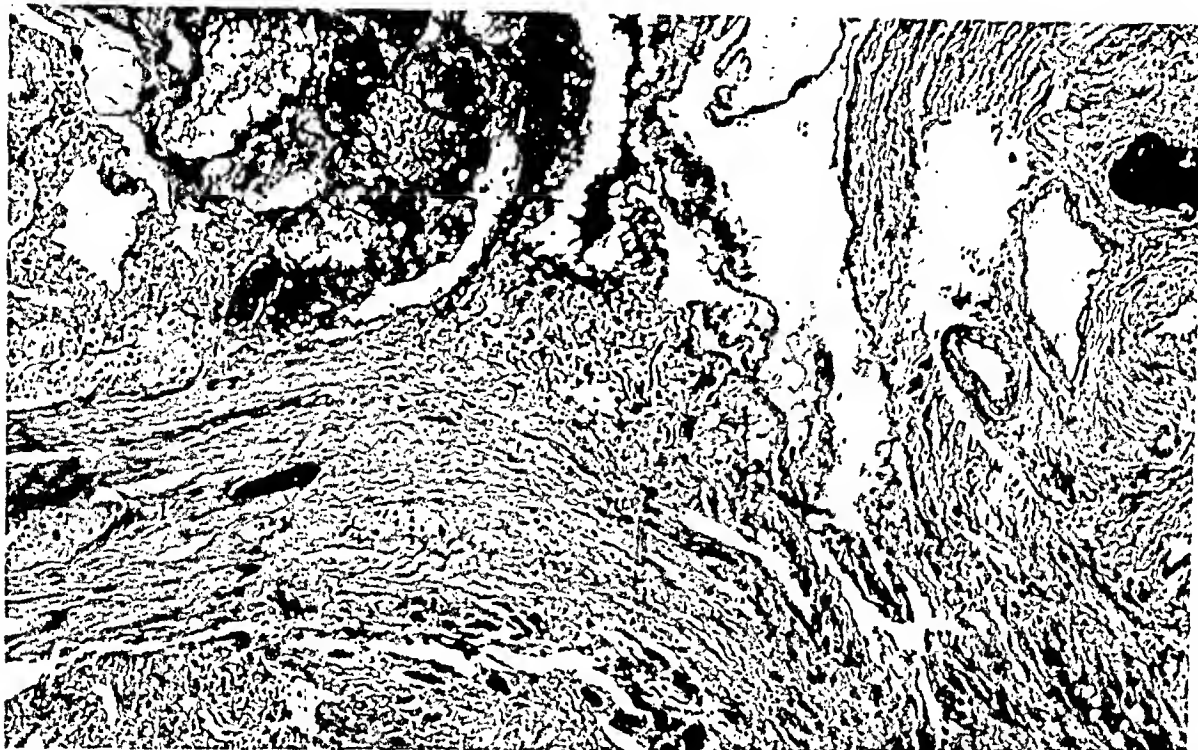


FIG. 2. The endothelial lining is evident in the cavernous spaces. Areas of compressed muscle tissue can be seen. Degenerative muscle changes are noted.



FIG. 3. Photograph demonstrating swelling on the upper inner aspect of left forearm.

At operation the tumor was found to consist of dilated veins in the substance of the flexor

sublimis digitorum muscle. The upper 2 inches of the muscle belly were removed. The upper end of the distal fragment was then sutured to the surrounding muscular structures.

Pathologically, the specimen consists of a piece of skeletal muscle approximately 4 by 3 by 3 cm. The muscle has a healthy appearance. Fascia and fat are noted. There is a mass within the muscle which has already been cut open. It appears to consist of smooth white tissue forming an arborized bush, with dark blood lying within. It is moderately firm; it appears to have been completely excised.

Microscopically, the lesion consists of long branching slits generally containing blood and lined by plump or flattened endothelium. This ramifies extensively in the muscle and fat. Some areas of extravasation of blood and old pigment deposition are noted. In one section there is a rather large recanalized thrombus.

Diagnosis was cavernous hemangioma of the muscle of the forearm.

Postoperatively, the patient did well and regained full function of her arm within a few weeks. In March, 1948 the patient had full function and no evidence of recurrence of the tumor.

## ETIOLOGY

It is the general consensus that hemangiomas are congenital in origin. There is the possibility that the tumor arises from abnormal embryonic sequestrations of vascular tissue which do not fit into the ordinary circulatory system and that they retain their embryonic characteristic (Cohnheim, Ribbert, Fraser, Ewing and Watson). Virchow stated that the condition possibly might arise as a result of a disease of the vasa vasorum and dilatation of pre-existing vessels. Muscatello thought that the connective tissue originated from the perimysium. Reclus and Magitot believed that the connective tissue originated from the adventitia of the arterioles and veins. Heredity does not seem to be a factor since there is no mention of two cases reported in the same family. Trauma doubtless does no more than to call attention to a pre-existing lesion although its secondary rôle may be a real one since it is possible for local contusion to cause a thrombosis within the venous and cavernous spaces of the tumor.

In a review of 1,308 hemangiomas (Watson and McCarthy) 10, or 0.8 per cent, occurred in skeletal muscles. Kornmann estimated that hemangiomas comprised 2 to 3 per cent of all benign tumors. Hemangiomas occur with about equal frequency in the two sexes. In many instances the condition was noted during childhood or adolescence. A study of the case reports reveals that the disease occurs predominantly within the first three decades. Shallow et al. state that the disease is almost entirely confined to the white race except for seven Japanese (2.1 per cent) and three Negroes (0.9 per cent). The author's first case happened to be an American soldier of Chinese descent. No other instance of occurrence in an individual of Chinese extraction has been reported to date.

There is no definite evidence to support the rôle of pre- or coexisting disease processes as a causative factor in hemangioma

formation. The possibility of systemic infections being such a factor has been mentioned in such affections as scarlet fever, diphtheria, appendicitis, pneumonia and the common cold. It is possible that some of the cases in the review of the literature have been hemangiomas of the tendon or the tendon sheath. These lesions, however, are relatively uncommon. In 1937 Harkins could find a total of only twenty-four cases involving the tendon or the tendon sheath in the literature.

## PATHOLOGY

Muscatello defined a hemangioma as a tumor mass composed of vascular channels and spaces, namely, venous, arterial, capillary or lymphatic, of a benign nature arising in various areas of the body. Some observers believe that these are true tumors and that they may grow and exhibit the characteristics of a neoplasm. Others look on the tumor as a simple malformation of the vessels (Sutter). It has been pointed out that these tumors of skeletal muscle arise in the vascular plexus of a muscle or in the perimysium between the muscle fibers (Muscatello). They represent a dilatation and overgrowth of vessels which, as a rule, are benign but which may potentially assume malignant characteristics. In the gross the tumors may often resemble a muscle composed of a varix-like structure. The color may be blue-purple due to the thin-walled cavernous spaces which can be found in the muscle substance. In other cases the color may be a yellowish gray, or reddish with a blue tint or a combination of these. The tumor is usually compressible, spongy or rubbery in consistency. The cut section may reveal areas of fibrous tissue with yellowish streaks and whitish septa. Other areas may exhibit communicating thin-walled blood spaces. The muscle fibers may be compressed in some areas more than in others and may show various stages of degeneration. In some instances there will be a sharp line of demarkation between the muscle tissue and the tumor and in other cases there may be

only a gradual transition. In the fresh specimen the cut section might show varying degrees of moisture and hyperemia. In other areas there may be the characteristic appearance of a blood-filled sponge. The microscopic picture reveals blood vessels of various sizes. The larger blood vessels may have endothelial lining but they lack the definite layers that are seen in normal blood vessels. The vessels may intercommunicate freely. The tumor consists of vascular elements comparable to cavernous, capillary, venous or arterial types. The predominating variety is the cavernous type. It is characterized by large irregularly shaped spaces in a connective tissue stroma with fibrous septa. Some authors indicate that veins are often absent and that when they do exist they are scarce and have no special characteristics. Benard and Lamy believe that the veins do play a rôle and that they prevent arterialization of their walls. New vessels are found within the structure of veins. The walls may be thickened, contracted, dilated or atrophied as the case might be. The dilated vessels may form irregular venous space cavities because of obstruction as in thrombosis due to injury. Thrombosis and hyalinization of dilated vessels may occur with all subsequent stages of organization and laying down of fibrous tissue masses. The capillaries have walls which may be formed with endothelium alone or there may be two or three layers of endothelium. The lumen varies in size. Muscatello was of the opinion that the capillaries proliferated and that buds were sometimes seen coming from the capillary wall. The supportive connective tissue in the parenchyma varies in different areas. This might account for the rubbery or sponge-like consistency of the structure.

Following trauma, inflammatory changes may develop in the tumor and round cell infiltration or even evidence of abscess formation might result from external stimuli such as injury, etc. At times the fibroblastic proliferation may be so marked as to resemble sarcoma. Mixed tumors

may also develop in combination with fatty tissue (Keller), vascular fibromas (Honsell) or lymph channels (Monzardo, Lueke). In some areas one may see cavernous-filled spaces containing erythrocytes and in others various stages of degeneration. In still other sections there may be evidence of calcification and actual ossification (Margarucci, Kolaczek, Rocher and Uzac). In none of the cases reported was there any evidence of malignancy. Geschickter and Keasby, in speaking of hemangiomas in general, state that "an occasional angioma may metastasize following trauma after repeated recurrence; that less than one per cent of benign hemangiomas subject to treatment fall into this group." In hemangiomas of skeletal muscle, growth is not by expansion as is usual in benign tumors but by infiltration.

The rôle of lymphatics and nerves in the tumor is negligible. Vessels predominate. Benard and Lamy demonstrated nerve fibers in the periphery of the tumors and Kirrmission found a nerve encased in the tumor. Such pathologic findings might explain the pain which develops during muscular contraction in these cases. The patient herein reported Case 1, did not complain of pain.

*Associated Pathology.* It is conceivable that circulatory effects on the cardio-respiratory system might occur in the untreated patients, especially when large multiple tumors exist. If the tumors continue to grow, erosion of the neighboring bone may occur.

#### SYMPTOMATOLOGY

It is the general consensus that hemangiomas of skeletal muscle may be present for many years, and even from birth, without causing symptoms of sufficient degree to warrant examination by a physician. Pain is usually the outstanding symptom. Weaver has pointed out that a glomus tumor is the only other small benign tumor that can simulate the excruciating pain which may be present in

hemangioma. In many instances the history of pain had its onset with some trivial injury to the tumor mass. This might have caused localized thrombosis with secondary swelling within the resistant surrounding connective tissue septa. The character of the pain may vary according to the degree or chronicity of the injury. It may be present only during the actual contraction of the muscle as Mondor and Huet and also Diedoff have pointed out. Since the muscle is thicker during the contractile period, it might allow pressure on the nerve. Likewise, pain may be due to the muscle mass pressing directly on some nerve branch as in instances of long narrow muscles like the sartorius.

Rarely are pulsations or bruits discovered. Such findings will manifest themselves only when there is free arterial communication. X-ray examination may reveal a distinctly outlined mass or, in some instances, a diffuse soft tissue swelling. In cases in which the presence of phleboliths can be ascertained the characteristic is said to be practically pathognomonic. The most important x-ray finding is the presence of phleboliths in areas of the body in which there are normally no large plexuses of veins. This picture would indicate an abnormal collection of vascular channels which in the case of skeletal muscle would be interpreted as hemangioma. Phleboliths appear as densely calcified round or oval areas, usually multiple and of varying sizes. (Table 1.)

#### DIAGNOSIS AND DIFFERENTIAL DIAGNOSIS

MacDermott stated that a correct pre-operative diagnosis was made in only 12 per cent of the series he studied. Clinical differentiations of hemangiomas of skeletal muscle from other tumors is not easy unless all aids available to the clinician are utilized. The history and clinical findings, including the tourniquet test as well as the x-ray studies, might be of help. The diagnosis may be suggested by aspiration of blood from the tumor. The presence of phleboliths in the x-ray would help to

establish the lesion as hemangioma. Any lesion which manifests itself as a swelling in the deep tissues may be confused with hemangioma of skeletal muscle. Conditions that may have some similarity are large varicose veins, phlebitis, foreign body,

TABLE 1\*

Symptoms	Cases	Percentage
Pain present.....	200	60
Pain absent.....	47	14
Mass present.....	320	98
Mass absent.....	6	2
Pulsation.....	10	3
Reduced size on elevation.....	22	6.6
Increased size on dependency position.....	20	6.0
Increased diameter.....	16	4.0
Contracture or atrophy.....	25	7.4
Deformity.....	86	26
Disturbed function.....	84	25
Limp.....	26	7.4
Phleboliths by x-ray.....	49	14
Phleboliths absent by x-ray.....	51	15

\*Symptomatology as noted by Shallow, Eger and Wagner.

hernia of muscle with changes in size on muscular contraction, inguinal and femoral hernia, ganglion, hygroma, tuberculosis of muscle, lymph nodes or bones, tenosynovitis, myositis and myositis ossificans, bursitis, synovitis and arthritis. Malignant neoplasms of skeletal muscle are exceptionally rare. Sarcoma do arise in the intermuscular connective tissue. Microscopically, a fibroblastic proliferation may be so marked that diagnosis of sarcoma must be considered although it is rare. Such a tumor would be a rapidly growing one and it might show a tendency to metastasize. Other tumors of muscle that must be considered are myoblastomas and rhabdomyomas. They do occur but they are also extremely rare. The location of the tumor may be of assistance since muscle hemangiomas are more common in the lower extremity than they are in the upper.

These tumors develop in unusual places and on occasion they may be multiple and

of varying sizes. There may be congenital deformities which include asymmetry and hypertrophy of bone (Bascom). MacDermott stated that one way of being certain of the diagnosis is to make use of the "exploratory incision," and not rely too much on radiologic and laboratory aids. On occasion it may be difficult to differentiate between capillary and cavernous hemangioma as well as between lymphangioma and hemangioma (Gross and Goeringer).

In instances of hemangioma of the arteriovenous type, arteriography can be carried out by injecting the radiopaque substance into an afferent artery near the tumor. X-ray has been employed to evaluate the results of treatment by deep x-ray therapy as well as by sclerosing agents. The radiopaque material can be injected either into the tumor or into a nearby vein so that the venous structure of the swelling may be identified. Fulton and Sosman pointed out that intravenous injections of radiopaque solutions are of assistance when phleboliths are absent. The extent of the angioma may be satisfactorily demonstrated. They used a tourniquet proximal to the tumor to prevent the immediate dissemination of the injected material into the general circulation.

#### TREATMENT

The preferred treatment of muscle hemangioma is surgery. Recurrence of the tumor is unlikely if complete surgical excision, well beyond the borders of the tumor, is carried out. Complete hemostasis and use of a tourniquet allow complete dissection.

Fulton and Sosman used x-ray therapy on two of the four cases which they reported. There was no apparent benefit realized with this type of treatment. They used a dosage of 700 roentgens in each series. Watson and McCarthy and Settergren have advocated the high voltage roentgen ray, particularly in extensive muscle angiomas. X-ray is more efficacious

in younger individuals. Davis and Kitlowski resorted to radium therapy in one case.

Pomeranz and Tunick have used sclerosing solutions and report salutary effects. The diffusion of the sclerosing agent through the cavernous spaces and fibrous tissue septa, however, cannot be considered physiologic. Dissemination of the agent into the general circulation may be rapid if the vessels are of large caliber in the tumor. Also, it is doubtful if the agent would penetrate deeply enough to destroy the endothelial layers. One can understand the use of a sclerosing agent in a cystic hygroma or a loculated lymphangioma but not in a cavernous hemangioma.

Others (Cascio) have resorted to electrocoagulation. Amputation may be used as a last resort since in some cases previous attempts at excision have failed and symptoms have persisted (Furlkroger, Riethus).

Shallow, Eger and Wagner have pointed out that partial excision alone, in 18 per cent of the patients in whom it was employed, was associated with recurrence or no improvement. In 265 cases (79 per cent) which they studied the tumor was locally excised with improvement or cure in 90 per cent. Partial excision was performed in seventeen patients (5 per cent) with improvement in 65 per cent.

*Prognosis.* With adequate surgical treatment, complete recovery should occur. The mortality should be negligible. In recurrent cases, or if malignancy is suspected, roentgen therapy or surgical measures of a more radical nature might be necessary.

#### SUMMARY

Hemangioma of striated muscle can no longer be considered as a rare tumor. In all probability occasional cases have been seen in most all of the large clinics. These tumors are frequently neglected by the patients themselves as well as by the surgeon. They are sometimes treated as strains, traumas, arthritis, bursitis or a hematoma and are too often treated expectantly. Careful examination should be made for localized pain and changes in



size of the tumor with suitable elevation or lowering of the affected limb. The remote possibility of malignant degeneration must be considered in cases of recurrence following surgery, especially after partial excision of the tumor. Postoperative roentgen therapy may be therapeutically effective in some of these patients.

Almost one-half of the patients whose cases were recorded in the literature displayed symptoms before the age of eleven years. It is a disease that usually occurs in the first three decades. The incidence of hemangiomas is approximately equal in males and females. These tumors are predominantly congenital in origin. The lesion presumably arises in the vascular plexus of the muscle or in the perimysium between the muscle fibers. The most commonly accepted classification includes the cavernous, capillary, venous and arterial types. The cavernous variety is by far the most common. The treatment of choice is complete surgical excision. Except in unusual cases in which the hemangioma is extremely large, excision can be accomplished in one stage. The mortality from operative treatment should be low and the incidence of recurrence should be negligible.

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# THERAPEUTIC STELLATE GANGLION BLOCK USING LOCAL ANESTHETICS\*

BLISS B. CLARK, M.D. AND SAMUEL WOLFSON, M.D.

Chief of Surgery, New Britain General Hospital

Attending Anesthetist, New Britain General Hospital

*New Britain, Connecticut*

THE increasingly extensive use of stellate ganglion blocks in modern military and civilian practice has stimulated interest in the technic and results of this procedure. We wish to com-

lateral approach is described by Volpitto and Risteen.<sup>5</sup> Posterior approaches are due to Peterson<sup>6</sup> and White.<sup>7</sup> A superolateral approach has been contributed by Arnulf.<sup>8</sup> Goinard<sup>9</sup> used the lateral approach.



FIG. 1. Forefinger on first rib after preliminary palpation.

mend one technic, little known and little used in this country, describe our modification of it and present our results with procaine stellate block in a general hospital overseas prior to V-E day.

The ganglion has been approached from anterior, anterolateral, posterior, superolateral and lateral directions. Anterior approaches are associated with the names of Leriche and Fontaine,<sup>1</sup> Ochsner and De-  
bakey,<sup>2</sup> Murphey<sup>3</sup> and Pereira.<sup>4</sup> An antero-



FIG. 2. The needle slid off first rib, was advanced 1.0 cm. and is now in place for injection.

After some experience with other methods we elected the method of Goinard modified as follows: The patient lies on the contralateral side with the elbow flexed to 90 degrees and the arm held by an assistant in a 90 degree abduction. The muscles of the shoulder girdle are thereby relaxed. The left forefinger palpates first, the anterior border of the trapezius muscle and

\* From The Surgical Service, New Britain General Hospital, New Britain, Conn.

then, deep to this and slightly anterior and medial the flat upper surface of the posterior portion of the first rib is felt. (Fig. 1.) The palpating finger moves as far medially as possible along the rib. (This step insures that the final position of the needle will

plane will be directed slightly posterior, rendering a puncture of the pleural cupola less likely.) Primary contact is then made with the rib immediately beneath the palpating finger. The point of the needle is caused to advance medially by short

TABLE I

Condition	No. Cases	Blocks	A	B	C	D	E
Neuroma of stump.....	2	4	0	1	3	0	0
Phantom limb with pain.....	15	23	1	3	12	6	1
'Burning' of end of open stump; no neuroma.....	3	8	0	2	5	1	0
Causalgia.....	4	4	0	1	1	2	0
Lesions of peripheral nerves with burning pain in anesthetized area of skin.....	6	10	0	1	7	2	0
Traumatic aneurysm; brachial artery with circulatory embarrassment.....	2	7	0	0	6	1	0
Multiple wounds of arm associated with circulatory embarrassment.....	2	3	0	0	1	2	0
Hysterical anesthesia of finger tips.....	1	2	2	0	0	0	0
Painful hand following old trauma.....	3	6	0	2	3	1	0
Painful wrist following old trauma.....	2	5	0	3	2	0	0
Kienbock's disease of the wrist.....	3	9	0	4	5	0	0
Old wound of hand with pain, coldness cyanosis and sweating	7	11	0	3	6	1	1
Cold, blue hand following severe cellulitis.....	1	1	0	0	1	0	0
Frost bite from high altitude.....	3	4	0	1	3	0	0
Raynaud's syndrome.....	6	18	0	9	9	0	0
Phlebitis of the arm.....	2	3	0	0	1	2	0
Venous obstruction cause undetermined.....	1	2	0	1	0	0	1
Hysterical claw hand.....	1	1	0	1	0	0	0
Pulmonary embolus (diagnosis proven incorrect at autopsy)	1	2	2	0	0	0	0
Tinnitus aurium following explosion.....	1	2	1	0	0	0	1
Painful wrist, cause undetermined; all investigations negative	1	1	0	1	0	0	0
Multiple wounds of arm associated with pain and circulatory embarrassment.....	2	4	0	0	3	1	0
Totals.....	69	130	6	33	68	19	4

A.—No relief of symptom

B.—Result lasting less than four hours

C.—Effect lasting one to three days

D.—Effect lasting three to ten days

E.—Effect lasting longer than ten days

form a more acute angle with the long axis of the body in the frontal plane, thus lessening the likelihood of subdural puncture.) The needle, preferably a 2 or 3 inch, short bevelled, flexible 22 gage, carried in the right hand with bevel facing posteriorly, punctures the skin .5 to 1 cm. anterior to the deeply palpating forefinger of the left hand. (Fig. 2.) (The slightly anterior skin puncture helps insure that the needle in its final position in the sagittal

steps until it is just felt to slide off the anterior surface of the rib at the region of the neck where the rib narrows. The needle is then advanced 1 cm. further and 15 cc. of 2 per cent procaine are injected. Before the injection is made aspiration is practiced to avoid the possibility of a subdural or intravascular injection. A drop of procaine solution is placed on the hub of the needle and the patient is told to take a few deep breaths. Marked respira-

tory fluctuation and sucking in of the drop will be seen if the point of the needle lies in the pleural cavity.

The method offers two technical advantages: (1) Its relative safety. No vital or potentially dangerous structures can be traversed by the needle before bony contact is made. (2) Ease in changing the direction of the needle. Changes in direction can be made easily because no large amount of soft tissue is penetrated before contact with the rib is made (1 to 3 cm.). This contrasts with other methods in which contact is made at depths of 5 to 6 cm.,<sup>5</sup> 6 to 7 cm.,<sup>2</sup> and 3.5 to 6 cm.<sup>3</sup>

The cases listed in Table 1 were treated with 15 cc. of 2 per cent procaine or 1½ per cent metycaine. In all cases Horner's syndrome was obtained. Two cases of pneumothorax occurred. These cleared in a few days with no treatment. The therapeutic results obtained were on the whole not encouraging. The therapeutic scope of this block when procaine or a similar agent is employed is not yet delineated. Of 130 blocks employed only four gave results which lasted more than ten days. Most encouraging results were obtained in the group with phantom limb with pain. In this group, all early amputees, symptoms when they returned were to variable

extents ameliorated and the use of narcotics and sedatives considerably curtailed.

#### SUMMARY

1. A useful and little used method of stellate ganglion block, somewhat modified from the original, is described.
2. The results of 130 blocks in sixty-nine patients using procaine and metycaine are summarized.

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# MECKEL'S DIVERTICULUM

HERMAN M. ZEIDMAN, M.D.

*Reading, Pennsylvania*

WHILE the subject of Meckel's diverticulum is a familiar one to the student in medical school, being mentioned in one or more courses in each of his four years of study, still the average practitioner sees and diagnoses them so rarely that the topic is soon forgotten and often disregarded in a consideration of either medical or surgical abdominal conditions. However, when examined objectively, the facts of the matter belie the little thought given to the subject. First, the incidence of Meckel's diverticulum has been reported in various pathologic reports to range between 0.14 and 3.0 per cent. This means that a busy practitioner probably sees in his office every week at least one patient that has Meckel's diverticulum. Second, the incidence and severity of pathologic changes occurring in Meckel's diverticulum are so great that prompt diagnosis and treatment are important and necessary. Third, the various pathologic conditions to which Meckel's diverticulum is liable are so diverse that a knowledge of the subject is essential if the problems of abdominal diagnosis are to be fully explored.

Meckel's diverticulum is a developmental anomaly due to the persistence of the embryonic vitelline duct. The primitive digestive tube consists of two parts, the foregut and the hindgut, separated by the wide opening of the yolk sac. As the intestinal tract develops this opening is gradually narrowed into a tubular stalk, the vitelline duct, which normally disappears between the sixth and ninth week of embryonic life. It may, however, persist throughout life as Meckel's diverticulum, a blunt out-pouching arising from the free border of the ileum. Its location varies from 3 to 100 cm. from the ileocecal valve and histologically its structure is the same

as that of the intestinal wall although approximately 15 per cent contains heterotopic tissue such as gastric mucosa or pancreatic tissue. Usually its end is free. It may, however, terminate in a fibrous cord which occasionally remains attached to the umbilicus.

When the numerous reported cases of pathologic Meckel's diverticula are analyzed and classified, it is apparent that while the symptoms, signs and course of the disease may be unusual each may be placed in one of the following four groups: (1) intestinal obstruction; (2) ulceration; (3) diverticulitis; (4) Intussusception.

*Intestinal Obstruction.* Halstead states that in his series of 991 cases of intestinal obstruction 6 per cent were due to Meckel's diverticula. The obstruction may be caused by the diverticulum becoming strangulated in a hernial sac (Wellington), by the diverticulum becoming adherent to an adjacent loop of bowel and causing kinking and rotation of the ileum (Rothman and Zetena), by contiguous inflammation and edema of the ileum secondary to diverticulitis or, as in the case herein reported, by becoming plugged with food.

*Ulceration.* As previously stated approximately 15 per cent of these diverticula contain heterotopic tissue, chiefly gastric mucosa. And this group is heir to all the complications of an ulcerated gastric mucosa. When ulceration first occurs, the symptoms may simulate and often are mistaken for those of peptic ulcer. If a large vessel becomes eroded at the base of the ulcer, massive and often fatal hemorrhage may occur. And if the perforation occurs, peritonitis of sudden onset, such as is seen in perforated peptic ulcer, becomes evident.

*Diverticulitis.* This is the most frequent complication to which Meckel's diverticula

are subject. The symptoms closely correspond to those of appendicitis and the history and physical examination usually do not help the differentiation. Abdominal pain, nausea and vomiting, slight fever and leukocytosis together with muscle spasm and local tenderness are present. At operation, usually performed with a preoperative diagnosis of appendicitis, the appendix may not appear inflamed which should lead to a careful examination of the ileum. The diverticulum will be felt as an inflammatory mass and should be brought out of the incision if possible. If this is not possible, it may be necessary to close the original McBurney incision and make a new transrectus incision. Rubber covered clamps are applied to the adjacent ileum both proximally and distally to the diverticulum and the underlying abdominal contents are carefully protected with warm gauze sponges. The diverticulum is excised at its base in the longitudinal direction of the bowel and sutured in the transverse direction, using a continuous Connell suture for the first layer and reinforcing interrupted Lempert sutures. Postoperative care includes adequate fluids, chemotherapy and nasal Wangenstein suction for several days.

**Intussusception.** Meckel's diverticulum may initiate an intussusception and the history and physical examination do not differ from those of the idiopathic type of intussusception. The patient is usually a child younger than two years of age who is suddenly seized with severe paroxysmal abdominal pain with evidence of shock. Blood is commonly passed by rectum. Immediate operation is indicated and either reduction or resection is performed.

The following four cases were encountered in a group of one hundred eighty five abdominal operations, giving an incidence of 2 plus per cent.

#### CASE REPORTS

**CASE I.** Mrs. F. M., age nineteen, had consulted the author on several occasions in reference to attacks of generalized abdominal pain

which lasted one to two days and recurred several times a month. Gastrointestinal x-ray was negative. In August, 1946 she consulted the author again for generalized abdominal pain of a more severe type and operation was decided upon. Blood count and urinalysis were entirely normal. At operation the appendix was found retrocecal and bound down by numerous adhesions. About 70 cm. from the ileocecal junction a diverticulum was found on the antimesenteric border of the ileum, measuring 6 cm. in length and 2 cm. in diameter. This diverticulum was acutely inflamed throughout and was removed as previously described. The pathologic report was as follows: (1) chronic appendicitis and (2) acute Meckel's diverticulitis.

**CASE II.** Mr. J. J., age eighteen, was seen in December 1, 1946, with a history of colicky pain starting two days previously periumbilically, but for the past twelve hours the pain had been localized to the right lower quadrant. The patient also complained of diarrhea and nausea but no vomiting. On examination the abdomen was rigid and tender throughout with rebound tenderness present. All these symptoms were most marked at McBurney's point. The white blood count was 15,100 with 82 per cent polymorphonuclear leukocytes. The preoperative diagnosis was acute appendicitis with probable rupture and peritonitis. At operation a large inflamed Meckel's diverticulum adherent to a gangrenous, suppurative appendicitis was found. The appendix was removed first and the diverticulum was then excised in a longitudinal direction and sutured transversely. The inflammation of the diverticulum was undoubtedly due to contiguity with the gangrenous appendix. The pathologic report revealed the following: (1) acute gangrenous appendicitis and (2) acute Meckel's diverticulitis.

**CASE III.** Mr. W. F., age eighteen, was seen by the author on November 17, 1945. The patient stated that about two hours before admission he developed generalized abdominal crampy pains which later localized in the right lower quadrant. He had also vomited twice and felt very nauseated. On examination, rigidity, tenderness and rebound tenderness were moderate throughout but were more marked at McBurney's area. The white blood count was 14,700, with 75 per cent polymorphonuclears. Preoperative diagnosis was ap-

pendicitis. At operation the appendix was found bound down by adhesions to the lateral abdominal wall, but no evidence of inflammation was seen. The appendix was removed and the ileum explored, leading to the discovery of Meckel's diverticulum about 50 cm. from the ileocecal junction. The diverticulum was filled with shredded food (on later questioning this food was found to be sauerkraut eaten with a frankfurter eight hours previously) causing an obstruction of the ileum. The diverticulum was removed and the patient recovered with no complications. The pathologic report was as follows: (1) Meckel's diverticulum containing sauerkraut and (2) chronic appendicitis.

CASE IV. Mrs. L. P., age twenty-four, complained of a dull ache in the right lower quadrant of twenty-one hours' duration. On examination tenderness on deep palpation at McBurney's point was present but no rigidity or rebound tenderness was seen. Laboratory studies were normal. The diagnosis was subacute appendicitis. At operation the appendix was found to be retrocecal and subacutely inflamed throughout. On routine examination of the ileum Meckel's diverticulum was found about 40 cm. from the cecum. It appeared to be normal, but was removed due to the high incidence of pathologic change to which diverticula are liable. The patient made an uneventful recovery. The pathologic report was as follows:

(1) subacute appendicitis and (2) normal Meckel's diverticulum.

#### SUMMARY

1. The importance of a knowledge of Meckel's diverticulum and its complications are stated.
2. A brief discussion of embryology aids in understanding the pathologic condition.
3. The pathologic disorder is classified into four main groups and the symptom-complex of each is presented.
4. Four cases are reported to exemplify the preceding statements.

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# TECHNIC OF OPERATION FOR VARICOSE VEINS

JOHN E. SUMMERS, M.D.\*

Associate in Anatomy, University of South Dakota  
Norwalk, Connecticut

THE following procedure has been found to give very satisfactory results in cases of varicosities involving the greater and lesser saphenous venous systems. The purpose of the operation is to remove the main trunk of the great saphenous vein (also the lesser saphenous vein when it is involved) and communicating veins. Sclerosing chemicals are never employed at any time.

*Preliminary Examination.* The preliminary examination includes the usual, complete physical examination and laboratory tests. Various tests previously employed to determine competency of the valves of the great saphenous and communicating veins are not used. Varicose degeneration of veins is progressive and usually starts in the leg where hydrostatic pressure is highest. If anything is done at all, the patient should have the complete operation in order to get the best results. In cases of varicose veins which have been preceded by phlegmasia alba dolens the patency of the deep veins is tested by applying an elastoplast bandage to the lower extremity and having the patient return in one week.

While more serious pathologic conditions must be treated first, there are no contraindications to the removal of varicose veins by the method herein described.

*Preparation of the Extremity.* The lower abdomen, pubis, groin and entire lower extremity are shaved, washed with green soap, water, ether and alcohol; both lower extremities are so prepared if the operation is to be bilateral.

*Preoperative Medication.* As the operation is performed under local anesthesia, adequate preoperative medication is essential to allay anxiety and prevent dis-

comfort. Usually  $\frac{1}{4}$  gr. morphine sulfate and  $1\frac{1}{2}$  to 3 gr. nembutal will keep the patient comfortable during the operation and prevent any unpleasant memories.

*Preoperative Examination of Varicose Veins.* The patient (dizzy from the medication) is assisted to stand up at the operating table while the operator sits on the floor and studies the varicosities by observation and palpation. The course of the greater saphenous vein is noted and bulbous dilatations along its course are marked as probable incompetent communicating veins. Large, incompetent communicating veins produce palpable defects in the deep fascia. Large collections of varicosities are marked for excision (the skin is scratched with a knife blade). Connections with the lesser saphenous vein are noted and the condition of the lesser saphenous venous system similarly studied.

*Draping the Patient.* In the female a narrow, folded towel covers the genitalia and is taped anteriorly and posteriorly; in the male the genitalia are taped up on the abdomen out of the way. The groin and entire lower extremity is painted with antiseptic solution and draped so that it will be available for operation; sterile towels are wrapped around the foot.

*Operation in the Groin.* The subcutaneous tissue in the groin over the fossa ovalis is widely infiltrated with a 1 per cent solution of novocain using spinal needles. The skin incision is made directly in the crease of the groin beginning about  $1\frac{1}{2}$  inches medial to the pulsations of the femoral artery and extending 2 or 3 inches laterally. (Fig. 1.) By placing the incision high, one comes down directly over the saphenofemoral junction and the dissection of the veins is facilitated. The incision is

\* Formerly Associate in Anatomy, University of South Dakota.

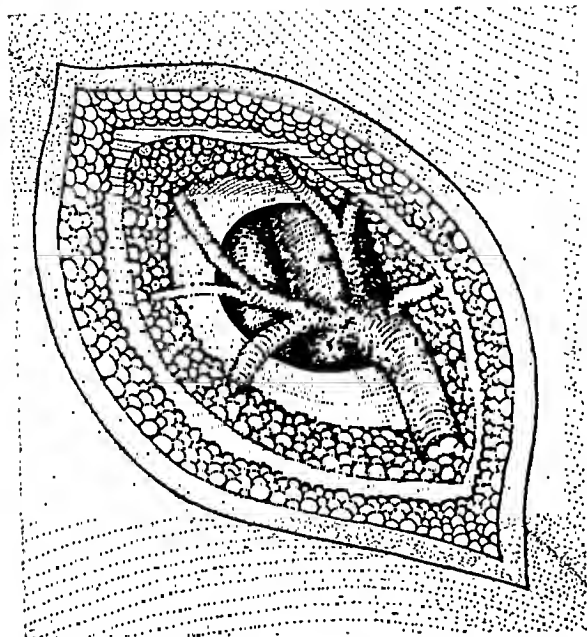


FIG. 1. Dissection of the veins at the saphenofemoral junction is facilitated by making the skin incision directly in the crease of the groin.

carried down immediately to the deep layer of the superficial fascia (continuation of Scarpa's fascia from the lower abdomen). There are no vessels of note between the skin and this deep layer of superficial fascia. The veins to be ligated lie beneath this layer of fascia. The deep layer of the superficial fascia is incised; one or more of the main tributaries to the terminal saphenous vein are revealed by gentle wiping with a gauze sponge. Dissection of the fossa ovalis is carried out by the use of a plain forceps and a curved Kelly hemostat. One looks for the superficial inferior epigastric vein, superficial circumflex iliac vein, superficial external pudendal veins (they may be duplicated or triplicated), lateral superficial femoral vein, medial superficial femoral vein and the great saphenous vein. The superficial external pudendal artery passes medially over the termination of the great saphenous vein while the deep external pudendal artery passes medially beneath the termination of the great saphenous vein. These are small arteries which can cause troublesome bleeding as they arise directly from the femoral artery. One obtains more

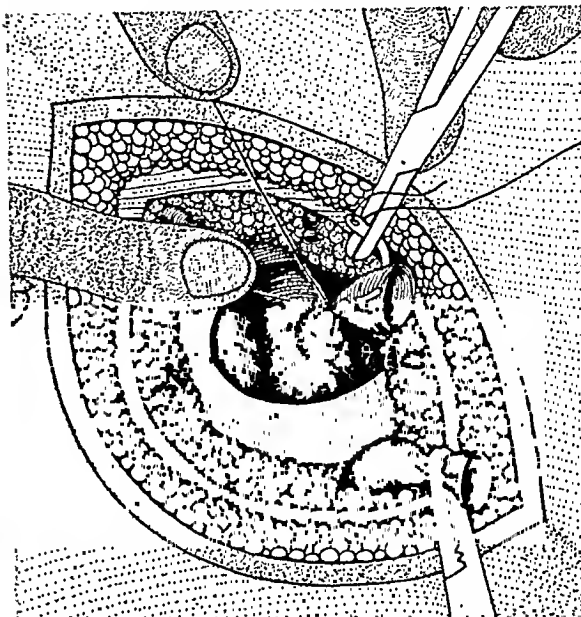


FIG. 2. The proximal stump of the great saphenous vein is ligated and suture-ligated.

information and satisfaction if all veins in this area are dissected before they are clamped, divided and ligated. After all tributary veins have been dissected, anomalies noted and the femoral vein demonstrated, the superficial veins are ligated; the proximal stump (Fig. 2) of the great saphenous vein is tied and suture-ligated distal to the tie to prevent the ligature from blowing off with an increase in intra-abdominal pressure. The defect in the deep fascia, i. e., the fossa ovalis, is closed with a figure-of-eight suture. (Fig. 3.)

*Stripping the Great Saphenous Vein.* The great saphenous vein is stripped with a Mayo stripper as far down the leg as possible, quite often as far as the medial malleolus. With adequate preoperative medication this stripping does not bother the patient to any serious degree. As the stripper meets an obstruction, the skin overlying the point is infiltrated with novocain and incised; the stripped segment of saphenous vein is brought out through the wound and the communicating vein causing the obstruction is clamped, divided and ligated. The stripping is then continued.

*Operation in the Leg.* Of great importance is the removal of the main saphenous



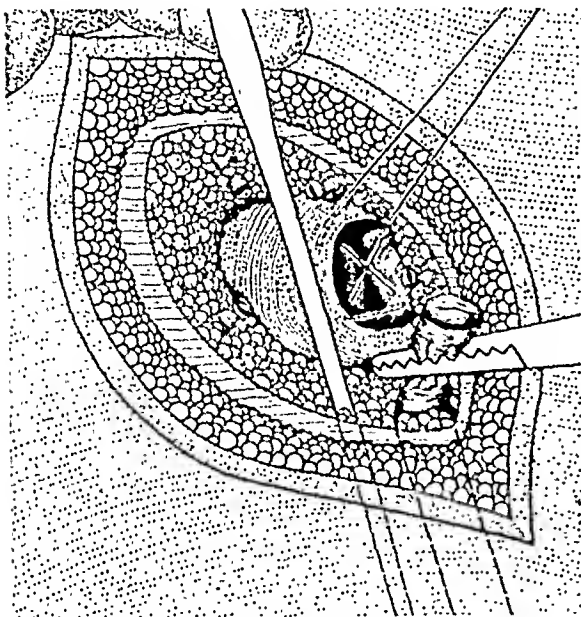


FIG. 3. The fossa ovalis is closed with a figure eight suture. The great saphenous vein in the thigh is stripped with a Mayo stripper until an obstruction is encountered. The skin over this point is infiltrated with novocain and a small incision is made. The saphenous vein is brought out through this incision and the communicating vein is isolated, clamped, divided and ligated. The saphenous vein is again threaded through the eye of the stripper and the stripping is continued.

vein and its incompetent communications in the leg. This is often the most time-consuming and most neglected part of the operation. In the presence of much induration and scar tissue, such as results from healed ulcers, stripping of the vein is impossible and excision of the varicosities through long skin incisions is necessary. (Fig. 4.) All this is performed under local anesthesia. The skin incision should be carried down directly to the deep fascia, as the main trunk of the great saphenous vein lies on this fascia. In the presence of large varicosities one will be rewarded by finding several, large communicating veins.

If the lesser saphenous vein is involved, the patient is turned over on his stomach and the vein is divided in the popliteal fossa and elsewhere if indicated. The lesser saphenous vein is more anomalous than the greater saphenous vein; one often has to incise the deep fascia in the popliteal fossa to reach the terminal end of the lesser saphenous vein.

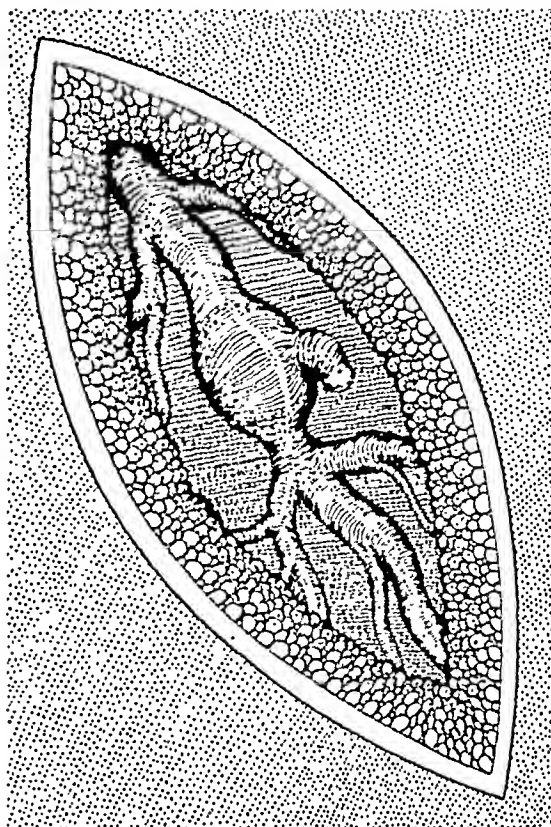


FIG. 4. In uncomplicated cases the great saphenous vein can be stripped out, down to the internal malleolus by bringing the vein out through small skin incisions at the sites of the communicating veins, the communicating veins being divided and ligated. When degenerative changes have caused extensive scar tissue formation in the subcutaneous tissue of the leg, the veins are excised through long skin incisions.

It will be recalled that the saphenous nerve accompanies the great saphenous vein in the leg, the sural nerve accompanies the lesser saphenous vein, and these nerves should not be ligated or divided.

Skin incisions are closed with interrupted cotton or silk sutures.

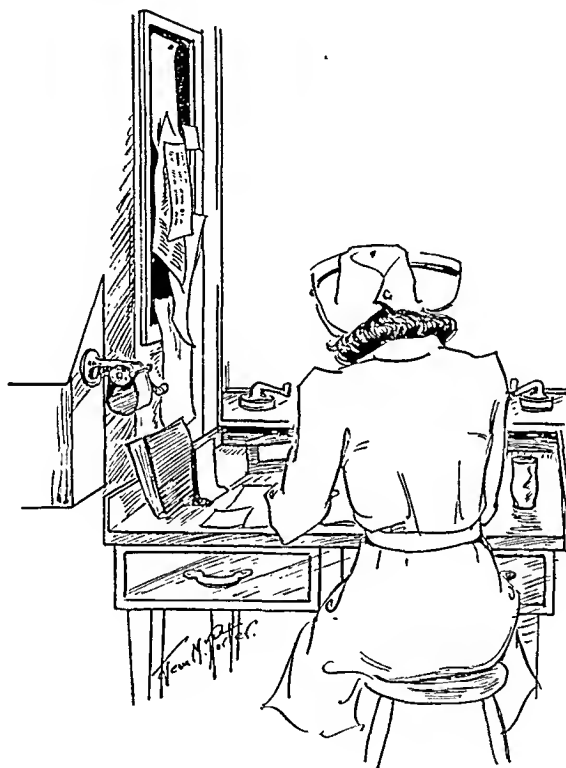
*Dressings.* Sterile gauze squares are taped over the wounds, cotton pads are placed over these and the entire lower extremity, from the toes to above the groin, is snugly wrapped with elastoplast pressure dressing.

*Postoperative Care.* The patient is walked from the operating table back to his room, walks for five minutes every two hours for the following twenty-four hours and remains ambulatory thereafter. He is discharged home the day of the operation,

or at his convenience, with instructions to remain active and return in ten days at which time bandages and skin sutures are removed. Pressure dressings are usually advised for several weeks postoperatively to prevent edema.

If the operation has been thorough, there will be no varicose veins of any importance left in the extremity. If an incompetent communicating vein has been missed, it

should be excised under local anesthesia. Sclerosing chemicals are never used at any time. The injection of a sclerosing chemical into a varicose vein produces not only a bad cosmetic result due to the resulting thrombosis, induration and pigmentation, but also is liable to produce ulceration, phlebitis, embolism and recurrence of the varicosity if there is any pressure on the vein from its deep connection.



# OXYGEN THERAPY IN SURGERY\*

WENDELL H. KISNER, M.D.

*New Orleans, Louisiana*

CLEAR understanding of the physiology of respiration is essential in order to appreciate the therapeutic value of oxygen in surgery. For that reason a brief review of this subject will be given.

Breathing originates in the respiratory center in the medulla oblongata. The metabolism of the respiratory center itself produces carbon dioxide and this plus the carbon dioxide in the blood stream stimulates the center to activity. The most important stimulant of the respiratory center is carbon dioxide whereas the most important respiratory depressor is oxygen lack. Strangely enough the rôle of oxygen lack as a depressor of respiration is given little consideration by many physicians. The idea that oxygen lack serves as a respiratory stimulant is a carry-over from the older physiology books and it is an idea that is extremely difficult to eradicate. Indeed, it is common to hear the remark, "the patient is not dyspneic," when a suggestion is advanced that oxygen therapy be instituted. It is of course true that oxygen lack stimulates the chemoreceptors, the carotid and aortic bodies but this is a weak affair. This reflex action is accounted for by adaptation. Adaptation is the rhythmical discharge of impulses set up by stimulation of a receptor. These impulses gradually diminish in frequency and may soon cease entirely although the stimulus continues to be applied at its original intensity. Drinker<sup>1</sup> has pointed out that this stimulation of breathing through oxygen lack is similar to nerve stimulation, e.g., to be effective there must be a sudden rise in intensity of the stimulus. Anoxia inhibits the discharge of impulses from the respiratory center and in the presence of anoxia the response of

the respiratory center to carbon dioxide is diminished.

Anoxia, clinically, as has been shown by Drinker<sup>1</sup> and others, develops insidiously and may become marked without noticeably disturbing the rate of respiration or the volume of breathing. This is a feature of anoxia that should be stressed in any discussion of oxygen therapy. Schnedorf<sup>2</sup> and his co-workers point out the danger of using cyanosis as an indication of anoxemia. Cyanosis depends on the presence of 5 Gm. of reduced hemoglobin for each 100 cc. of circulating blood. When cyanosis is present, it is a sign of marked anoxia. After marked blood loss or in the presence of anemia, cyanosis will be absent even with a marked degree of anoxia.

Anoxia creates a most vicious circle that is difficult to break after the oxygen lack has become marked. During the insidious development of anoxia there is an increase in permeability of all the capillaries due directly to oxygen lack. Drinker<sup>1</sup> states that the lung capillaries lie in a foamy-like tissue separated by a single layer of epithelial cells from the air. Fluid passes through the capillary walls because of their increased permeability in the presence of oxygen lack and pushes this layer of epithelial cells away from the endothelium of the capillary. This decreases the oxygen intake as the capillaries are separated from the alveolar epithelium by a layer of fluid. Since the endothelium of the capillaries of the lung receive their oxygen directly from the air and not second hand from the blood, this makes the lung capillaries dependent on the oxygen content of the alveoli in whose walls they lie. Therefore, as transudation from these vessels begins they are steadily more and more widely separated from their oxygen

\* From the Department of Physiology, Post-Graduate Division of Medicine, Tulane University, New Orleans, La.

supply. In the presence of continuous leakage from the lung capillaries the blood vessels become surrounded by rings of fluid and many of the thin walled capillaries rupture. As the anoxia increases in the lung, due to the interposition of a sleeve of fluid around the alveolar capillaries, the respiratory center is more and more depressed which slows up the rate and depth of respiration and in turn creates more anoxia in the lungs. Thus a vicious circle is set up that is difficult to break when pulmonary edema has become advanced. Drinker<sup>1</sup> further states that of all the factors leading to edema of the lungs increased permeability of the lung capillaries is by far the most important and of all the possibilities for inducing it anoxia is infinitely the most frequent. He further states that pure oxygen when breathed has five times the power to penetrate exudates and reach anoxic parts of the lungs that "air-oxygen" has.

Anoxia has been divided into four classes by Bancroft<sup>3</sup> and others: (1) Anemic anoxia which is a result of oxygen content being limited because of decreased hemoglobin; (2) anoxic anoxia which is a result of lowered oxygen tension as in pneumonia; (3) stagnant anoxia which is a result of reduced blood volume or reduced blood flow with inadequate oxygen to the tissues and (4) histotoxic form as in carbon monoxide poisoning in which tissue cells are incapable of using oxygen.

The use of oxygen in therapy was first popularized by Haldane in the first world war. Haldane has been credited by numerous writers with the saying that anoxemia not only stops the machine but wrecks the machinery. Oxygen was widely used in World War II and was available in almost all areas occupied by our troops. According to Behnke,<sup>4</sup> it was Barach who rendered invaluable service to aviation by calling attention to the need for oxygen at elevations of ten thousand feet or more. Due to the widespread use of oxygen in aviation it was relatively easy to obtain oxygen

for therapeutic use in most places during the recent war.

During the recent war as a result of the pendulum swinging away from the use of carbon dioxide and oxygen mixtures pure oxygen was supplied for oxygen inhalation therapy. Behnke,<sup>4</sup> Mayerson,<sup>5</sup> Kety,<sup>6</sup> Schmidt<sup>6</sup> and others have pointed out the value of giving carbon dioxide with oxygen. Kety and Schmidt demonstrated that inhalation of 5 to 7 per cent carbon dioxide was associated with a consistent increase in cerebral blood flow averaging 75 per cent. Behnke<sup>4</sup> states that it is well to emphasize again that carbon dioxide is an effective physiologic agent in bringing about not only increased pulmonary ventilation but also augmentation of cerebral blood flow. Mayerson<sup>5</sup> believes this latter effect of carbon dioxide is an extremely important factor and should be utilized when giving oxygen. He has shown in experiments with medical students on a tilt table that carbon dioxide inhalation prevents fainting due presumably to its stimulating effect on cerebral circulation. In view of the increasing frequency of reports in the literature concerning the beneficial effects of using carbon dioxide with oxygen it is believed this mixture will be more widely used in the future.

In any consideration of oxygen therapy in surgery it is well to keep in mind the fact that the drugs most widely used in surgery, morphine sulfate and the barbiturates, exert a depressing effect on the respiratory center.

Some of the surgical conditions for which oxygen therapy is especially beneficial will be considered.

*Head Injuries.* Schnedorf<sup>7</sup> and co-workers demonstrated that following experimental concussion in dogs there was a depression of oxygen saturation in blood from the femoral artery and the oxygen saturation could be elevated by giving oxygen. In their work with humans suffering from cerebral concussion they found only a mild oxygen deficiency; however, in some cases the depression was as much as

34 to 44 per cent. These authors believe that oxygen deficiency may be greater than the level of blood oxygen unsaturation would indicate. They point out that the elevation of body temperature seen in so many patients with head injury produces a marked increase in tissue metabolism and increased demand for oxygen. When shock is present this adds to the concussion anoxia.

Varying degrees of anoxia following concussion might be expected according to these authors on the basis of shock, alterations of respiration due to injury of the respiratory center, neurogenic hyperthermia due to disturbance of the temperature regulating center, decreased circulation through the brain due to an increase in intracranial pressure, vasodilation, edema and hemorrhage. Chase<sup>8</sup> states that ganglionic nerve cells are more susceptible to oxygen deficit than any other cells of the body and the effects of anoxia on the brain are profound and destructive. Lindquist and LeRoy,<sup>9</sup> working with dogs in which experimental concussion had been induced, came to the conclusion that the impaired cerebral blood flow following head injury is affected relatively little by oxygen therapy whereas cerebral oxygen consumption is strikingly increased. They state that the oxygen consumption of the brain is not dependent on blood flow alone or on arterial oxygen alone. These authors believe the metabolism of the nerve tissues and their ability to use oxygen is directly affected by head injury. One hundred per cent oxygen was used in these experiments. It is possible different results might have been obtained as regards cerebral blood flow if a mixture of oxygen and carbon dioxide had been used in this work.

With the vigorous treatment of dehydration and frequent spinal taps that is still popular in some hospitals, patients with severe concussion who survive for twelve to twenty-four hours not infrequently develop pulmonary edema and expire. This pulmonary edema is usually thought

of as a terminal affair and beyond prevention. It is the author's experience that the early use of oxygen and carbon dioxide will help prevent this state of affairs. Given a severe closed head injury there is a certain amount of intracranial damage which as yet has not been thoroughly explained. Due to this disturbance there is some damage to the cerebral capillaries with leaking of fluid from the vessels and a slowing of cerebral circulation. In addition, there is a disturbance of the respiratory center itself in many cases. This condition or combination of conditions produces anoxemia of the respiratory center which in turn causes depression of the center with further increase in anoxemia. This mechanism as has been stated will affect the lung capillaries causing them to leak fluid along with a slowing of the rate and depth of respiration with a deepening of anoxemia thus producing a vicious circle. If not broken, this circle leads to an increasing intracranial pressure and extensive pulmonary edema. Shock when present adds to the production of anoxia in these cases.

On my service during my last two years in the army, all patients with cerebral concussion, except those with very mild cases, were routinely given oxygen by means of the BLB mask continuously with a short interval of rest every twelve hours. In addition these patients were given adequate fluids and sedation. The sedation most commonly used was sodium amytal parenterally and in comatose patients fluids were given by vein in amounts of 2,000 to 2,500 cc. of 5 per cent glucose daily with only 1 liter containing normal saline. Careful attention was given the bladder in comatose patients and an indwelling urethral catheter was routinely used with a daily irrigation of  $\frac{1}{4}$  per cent mercurochrome solution. Meticulous nursing care was one of the important factors in the good results obtained with these patients. No spinal drainage or dehydration therapy was used. Diagnostic spinal punctures were not done.

It was found to be necessary in the comatose or semicomatose patients to strap the BLB mask in place with adhesive and use soft flannel restraints on the hands to prevent removal of the mask. After an hour or so these patients become less restless and tolerate the face mask well. In several patients in whom the period of unconsciousness lasted for twenty-four or more hours the removal of the oxygen mask tended to bring on restlessness which disappeared after oxygen was again started. It was also noted that patients getting oxygen required much less sedative than those treated without oxygen. The author believes that even better results would have been obtained in this group of patients with a mixture of carbon dioxide and oxygen rather than the pure oxygen supplied by the army because of the need for the stimulating effect carbon dioxide exerts on the circulation of the brain.

*Shock.* Gregerson<sup>10</sup> quotes Harkins<sup>11</sup> and points out that in shock with a gradual fall in cardiac output there are progressive and eventually profound changes in the oxygen consumption, arteriovenous oxygen difference and ventilation. These findings and the clinical evidence of slowed blood flow disclose a condition of stagnant anoxia. The early judicious use of oxygen and carbon dioxide mixture along with the other means of treating shock may well be the deciding factor in saving the patient. After extensive blood loss the early use of oxygen and carbon dioxide may prevent irreparable damage to the brain by anoxia while the blood loss is being rectified by transfusions of whole blood.

*Postoperative Ileus.* With the present use of early Wangenstein's decompression using the Levine and Miller-Abbott tubes, postoperative ileus is not the specter it formerly was to the surgeon. In spite of all the surgeon's efforts ileus at times will develop and become a serious problem. In these cases the use of oxygen is an important adjunct. Oxygen will reduce the partial pressure of nitrogen in the

lungs to almost zero from a normal of 570 mm. of mercury. As a result of this reduction in the lungs nitrogen in the blood diffuses into the alveoli and is expired thus relieving some of the tension on the bowel wall. Distention of the bowel wall itself compresses the blood vessels and causes local anoxemia with damage and increasing loss of tone to the bowel.

*Postoperative Pulmonary Complications.* Use of a carbon dioxide-oxygen mixture postoperatively as a preventive of postoperative pulmonary complications is not as widespread as it should be. Too often oxygen is not used until after the development of postoperative pneumonia, atelectasis or pulmonary edema. The patient who has had an upper abdominal operation has a reduced vital capacity due to splinting of the lower thorax and if an inhalation anesthetic has been used the respiratory center may be depressed. Further, the postoperative use of morphine sulfate and the barbiturates add to the depression of the respiratory center. All of these factors tend to produce a state of anoxia that cannot be recognized clinically in its early stages. As anoxia progresses with perivascular fluid collecting in the lungs a fertile field is prepared for the plugging of a bronchus or for the invasion of the lungs by pathogenic organisms. Indications for the use of carbon dioxide-oxygen after postoperative pulmonary complications are obvious but its use as a prophylactic measure is of more importance.

*Thoracic Wounds.* Wounds of the thorax are a must on the oxygen therapeutic list. Many a soldier was saved in World War II by the early use of oxygen and whole blood transfusions. In extensive chest wounds with hemopneumothorax and collapse of an entire lung the vital capacity is reduced to an alarming extent. The rapid improvement of these patients with oxygen and adequate blood replacement is almost phenomenal. Marked central nervous system damage may occur early in these patients thus further increasing their state of anoxemia. Under

this heading may be considered thoracic surgery in elective cases. The use of oxygen postoperatively in this type of patient is important to prevent anoxia developing secondary to the lowered vital capacity which follows such surgery.

**Pulmonary Burns.** The admirable work of the Massachusetts General Hospital Group in the Coconut Grove disaster drew attention to the extensive pulmonary damage possible on inhalation of hot gases in flash burns. This type of burn was not uncommon during World War II. Some of these patients exhibited only mild burns of the face that proved fatal. At necropsy, inflammation and edema extended throughout the major part of the bronchial tree with the epithelium completely denuded in places. The most severe case of this type on the author's service was an aviator who suffered extensive external burns in addition to the pulmonary burns. The entire airway was seared with sloughing of the epithelium and patchy consolidation of the lungs. This patient in addition to plasma and pressure dressings was given oxygen immediately on admission to the hospital and the oxygen was continued until the patient expired fifty hours later. The remarkable feature of the necropsy findings was the almost complete absence of pulmonary edema in spite of the involvement of practically the entire lung.

Anoxia develops early in this type of burn with the production of extensive pulmonary edema which may rapidly prove fatal. Marked excitement as has been mentioned by others is usually noted in these patients when first seen. This excitement is a result of oxygen lack of the brain. Oxygen should routinely be given to all patients who exhibit burns about the face or whenever there is any question of the inhalation of smoke and hot gas. Such patients need morphia for their pain and this is a further depression to the respiratory center that is already depressed by oxygen lack.

**Thyrotoxicosis.** Boothby<sup>12</sup> and others have pointed out that anoxemia develops

easily in thyrotoxicosis. This is appreciated by most surgeons and oxygen is more freely used in these cases than in other surgical problems. Because of the elevated basal metabolism, thyrotoxic patients require a large amount of oxygen postoperatively. Mclver and Winter<sup>13</sup> working on animals with thyrotoxicosis produced evidence that anoxia is capable of producing degenerative changes in the liver. They believe this may explain the lesions found in the livers of patients dying of hyperthyroidism. Britton and Kline<sup>14</sup> working with animals demonstrated that animals exposed to a carbon dioxide-oxygen mixture before exposure to low barometric pressure had longer survivals than those animals that did not have the carbon dioxide-oxygen mixture. When this same experiment was carried out with glucose being given in addition to the carbon dioxide-oxygen mixture, these animals withstood anoxia even better than the group getting only carbon dioxide-oxygen and fifteen times as long as the untreated animals. These authors suggest that the remarkable beneficial effects of carbohydrates in enabling animals to withstand anoxia is due to a supply of energy for cerebral activity during anoxia. This work suggests that in thyrotoxic patients the use of oxygen by inhalation and glucose by vein in addition to a high carbohydrate diet preoperatively for several days may result in a much smoother postoperative course.

This beneficial effect of carbohydrates may explain why hypertonic glucose was apparently of some value in the dehydration treatment of certain cases of head injury.

Following thyroidectomy, there may be some obstruction to the flow of air through the air passages into the lungs. This may result from injury to one or both of the recurrent laryngeal nerves or from edema secondary to the trauma of an endotracheal tube or to operative trauma. In such cases the use of a mixture of helium and oxygen is indicated. Barach<sup>15</sup> in 1934



first introduced helium and oxygen as a method of treating certain conditions which obstruct the free passage of air to and from the lungs. Helium is of low molecular weight and has a specific gravity one-eighth that of oxygen. It acts as a vehicle for oxygen and allows a much greater efficiency than is possible with pure oxygen. Barach recommends a mixture of 80 per cent helium and 20 per cent oxygen.

Segal,<sup>16</sup> quoting Boothby and Haines, states that one can generally prevent postoperative stridor and postoperative storm and minimize the need for tracheotomy by the use of oxygen and helium and oxygen mixtures before and after thyroidectomy.

*Anesthesia.* Because anesthesia and surgery are so closely allied a few points concerning the use of oxygen in anesthesia will be mentioned. All inhalation anesthetics are respiratory depressors and the well trained anesthetist is cognizant of the specter of anoxia and uses oxygen and carbon dioxide freely in the operating room. After the patient leaves the operating room still under the effects of an inhalation anesthesia which continues to exert a depressing action on the respiratory center, the use of carbon dioxide-oxygen is just as important as it was during surgery. Oxygen therapy should be given to these patients routinely after operation especially if the operation was in the upper abdomen.

Beecher<sup>17</sup> states that respiratory failure is the usual cause of death under spinal anesthesia. The mechanisms involved may be: (1) direct action on the medullary centers by diffusion of the drug to the fourth ventricle; (2) ascending block of the intercostal and phrenic nerves and (3) insufficient flow of blood through the respiratory center as a result of circulatory depression. Aside from these three mechanisms it is the author's opinion that another mechanism of failure of respiration in spinal anesthesia may be present. At times a patient who has had a spinal anesthesia (pontocaine, novocain or mety-

caine), especially if moved to another position on the operating table or transferred to another table, may have a slowing or complete stoppage of respiration without a preceding fall in blood pressure or ascending block of the intercostal nerves. The question of systemic absorption of the drug with a direct depression of the respiratory center must be considered. Mayerson<sup>18</sup> has suggested that the blocking out of all peripheral reflex stimulation of the respiratory center from the muscles of the lower part of the body and lower extremities may be a factor in producing a slowing of respiration.

Lee and co-authors<sup>19</sup> administer 100 per cent oxygen as a routine procedure in fractional spinal anesthesia giving it continuously through a nasal catheter during the entire operative procedure.

Carbon dioxide-oxygen mixture used routinely for several hours postoperatively on all patients who have had a spinal anesthetic should lower the incidence of postoperative pulmonary complications by prevention of anoxia.

Since the use of sodium pentothal intravenously for anesthesia has become so popular, the rôle of this drug as a respiratory depressor should not be forgotten. Schendorf<sup>20</sup> has shown that barbiturate anesthesia produces a decrease in oxygen saturation of arterial blood which persists for more than four hours. This decrease in oxygen saturation can be eliminated by the administration of oxygen by mask or nasal catheter. Oxygen should be administered to the patient who has had barbiturate intravenous anesthesia. This can be done during or immediately following the operation for several minutes. A longer period of oxygen therapy is usually unnecessary in this type of patient unless the operative procedure has been long and a large amount of the drug used or the patient exhibits a reaction following the administration of the anesthetic.

In addition to the uses of oxygen in surgery that have been mentioned, Boothby and co-workers<sup>12</sup> point out the



value of oxygen therapy to alleviate headache following encephalography and to combat infection caused by anaerobes. In the latter, oxygen helps remove nitrogen from the gas spaces in the tissues and thus decreases the tension with resulting improvement in circulation.

#### COMMENTS

Oxygen is a valuable therapeutic agent in surgery and oxygen and carbon-dioxide in a proportion of 7 per cent carbon dioxide and 93 per cent oxygen should prove to be of even greater value than pure oxygen alone. Oxygen's greatest use is in the prevention of anoxia.

All patients for elective surgery should have a hemoglobin check. If adequate hemoglobin is not present, surgery should be postponed until the oxygen-carrying power of the blood is improved by whole blood transfusions. Adequate blood replacement during surgery and the use of oxygen, especially if an inhalation anesthetic is used, should be carried out both in the operating room and postoperatively.

Coller and his co-workers<sup>21</sup> have demonstrated in their studies of blood loss at operation that the loss is almost always greater than the surgeon estimates. They state the only wholly suitable replacement for operative blood loss is whole blood and the greatest benefits result when the blood is given as the loss occurs.

#### SUMMARY

The use of oxygen and especially a carbon dioxide-oxygen mixture (7 per cent carbon dioxide and 93 per cent oxygen) is not as widespread in surgery as it should be as a preventive and therapeutic aid for anoxia. Anoxia develops insidiously and the best treatment is prevention by the early use of inhalation oxygen. Cyanosis and dyspnea are not present in the early stage of the development of anoxia.

A knowledge of the physiology of respiration is essential for a clear understanding of the rationale of oxygen ther-

apy. The use of oxygen in several surgical conditions is discussed.

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# FRACTURE DEFORMITY REDUCTION AND FIXATION SPLINTS

## LINEAR FRACTURE THROUGH THE HEAD OF THE HUMERUS

HARVEY C. MASLAND, M.D.

*Philadelphia, Pennsylvania*

IT has been my endeavor in previous publications to present a plan of non-operative treatment particularly adaptable to vicious fracture deformities. Treatment of these deformities in the long bones utilizes mechanical factors that have not been developed heretofore. Essential to treatment has been the development of a splint capable of applying these factors to a fractured limb whether the patient is old or young, slender or stout.

There has been steady improvement which makes for simplicity of construction of splints and for diversification of designs for practically all fractures. The writer has had an education in the use of these new methods of treatment; there has been no change in the underlying principles involved.

The construction of the splints is based upon the principle of placing comfortable anchorage upon adjacent bones above and below the fractured member. Metal strips are attached to these anchorages on both sides of the limb with sleeves that enclose the overlapping ends. Thus, the necessary extension can be secured and then retained by clamping the sleeves.

While the chief design of this communication is to present an interesting case of fracture of the humerus, I cannot refrain from commenting on some present methods of treating fractures, particularly those in and about the neck of the femur.

Present operative procedures utilize an assortment of plates, screws, wires and pins of various dimensions with some ingenious devices to facilitate their use.

In the examination of many thousands of young men for the armed services I have

found that osteomyelitis following operation for fractures is one of the most frequent orthopedic disabilities.

In fractures about the hip joint the abduction cast was heralded as the proper procedure a few years ago. Today, however, it is giving way to the operative insertion of large pins and screws. One trying to nail two boards together with the lower board unsupported knows how difficult it is to penetrate the lower board. The same principle applies to the unstable proximal fragment. The use of a large pin or screw, one or several, cannot but cause much destruction of the cancellated bone and damage to the limited circulation.

A requirement imperative to the performance of this operation is that the two bones should be in a sufficient degree of alignment. Recently an elderly, stout woman sought my help. Eight months before a pin had been inserted which had penetrated the distal fragment, and, carrying this fragment with it, slid along until it penetrated the displaced proximal fragment near the more stable head. There was increased deformity with no contact of the fragmented ends, no union and with necrosis of the head.

In a previous communication I made the following claims for my strictly non-operative plan of treatment for fractures in and about the femoral neck: No anesthesia of any sort is required. The limb is stabilized by the splint before any attempt is made to correct the deformity. The eversion of the limb is corrected and controlled (Malgaigne). The limb can be brought practically to its normal length. Lateral traction can improve the length

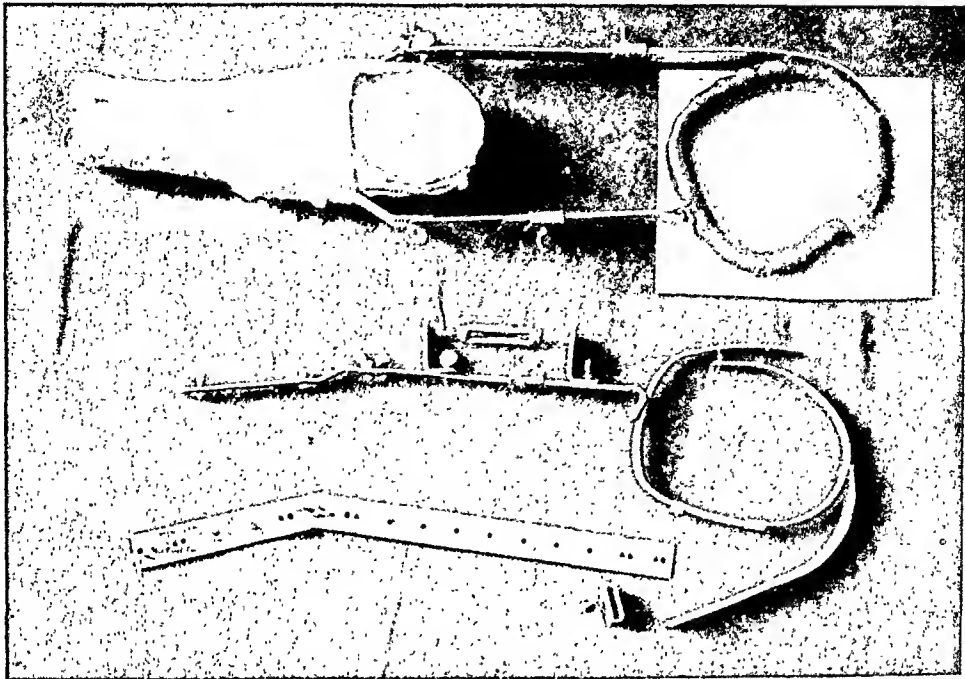


FIG. 1. Humerus splint showing adjustable shoulder ring, attachable turnbuckle assembly and elbow joint.

of the neck. Pain is eliminated permanently. The patients can lie down, sit on the side of the bed, sit in a wheel chair or use crutches. Of course, the degree of liberty depends upon other factors present in the individual patient.

An experience as to the stabilizing control of the splint was had by the author when he was called to treat a seventy-nine year old emaciated woman with a fractured hip. She weighed 70 pounds; senile dementia and a wandering delirium were present. She had a long-standing, persistent cough with profuse expectoration, purulent cystitis, constant dribbling and a bloody vaginal discharge. I did not propose that the pain of the fracture should add to her discomfort. The splint was applied, bringing the limb to practically its normal length and alignment. On the fourth night the patient tumbled out of bed in her restless delirium. The nurses thought that they had her safely caged but on the sixth night she repeated the tumble. Examining her the next day, I found the body covered with ecchymotic bruises but the limb was held in the position in which it had been placed. At no time when brought back to

conscious response did she admit that she had any pain in the hip. She died the next day.

Figure 1 shows the splint applicable to treatment of all fractures of the humerus. With the forearm semiprone and flexed at right angles, a strictly unpadded cast is applied from the carpal bones up the forearm to, but clearing, the joint. A projection of the cast posteriorly engages the olecranon process. Plates are embedded securely in the cast on both sides with the pins on the projecting ends placed on opposite sides in the axis of the elbow joint. The adjustable ring is fitted to rest upon the clavicle, the ridge of the scapula and the ribs. Loosely attached to the ring are splint arms which extend a suitable distance along the inner and outer sides of the arm. Attached to the cast plates are splint arms which extend upward and underlie the shoulder arms. These overlapping arms are enclosed in a clampable sleeve thereby stabilizing the arm against any erratic movement.

The splint arms under extension, both manual and with screw turnbuckle assemblies, give the required correction. In this

connection the power necessary to correct the deformity is much greater than that necessary to retain the correction. Muscle contraction under stimulation is a powerful force; relaxed muscle is the most easily stretched tissue in the body. Note the yield of the quadriceps muscle with flexion of the knee. The author does not have contraction of the muscle in his plan of smooth stabilized extension. Nevertheless, it is imperative that the pressure necessary to correct the deformity be eased immediately to a stage of complete pressure comfort. This is quite sufficient to balance muscle tonus.

With the hardening of the cast, there is retraction from the skin surface. To prevent sagging of the wrist and possible chafing against the lower edge of the cast in arm fractures, a few turns of a bandage are applied to hold the wrist to the upper edge of the cast. The clinical case illustrated in the x-rays presents some interesting features pertaining to fractures of the head of the humerus.

#### CASE REPORT

Miss M., fifty years of age and weighing 200 pounds, fell on a stairway. The x-rays showed a comminuted fracture of the left humerus. There was a fracture through the surgical neck, a separation of the tuberosity and, what is most rare, a cleavage through the middle of the head. (Fig. 2.)

It will be recalled that the humerus has no teres ligament to hold it to the glenoid fossa. The capsular ligament is sufficiently relaxed to permit free movement of the arm. Traction applied to this section of the humerus stretches the ligament with the head following. In fractures elsewhere other factors direct the yield under extension to the place of least resistance which is at the site of the fracture.

While the patient was seated in a chair, the splint was applied and sufficient extension was given to separate the bone contact and permanently relieve the pain. The splint permitted free movement of the arm forward and backward and about 60 degrees of lateral elevation; movement of the elbow joint was sufficient to aid in eating. A triangular bandage sling completed the dressing.



FIG. 2. Comminuted fracture of the left humerus involving the head, greater tuberosity and surgical neck before treatment.

Routine observation was pursued during the six weeks the patient was in the splint, with no complications noted. An X-ray taken after removal of the splint showed some bone union and the head occupying the lower segment of the glenoid fossa. (Fig. 3.) The patient was instructed to climb the wall with her fingers and, more important, to rest her forearm on the arm of the chair and throw her body weight in increasing measure against the shoulder.

Figure 4 taken six weeks later shows bone union and the head of the humerus in normal position. Normal function of the arm was obtained.

This fracture is interesting because of the great rarity of fractures across the crown of the head. A fairly extensive search of the literature failed to disclose a record of a similar case. Fractures of the anatomic neck with more or less marginal involvement of the head are rare but more common. Gunshot fractures are not included. It was fortunate here that the vitality of the head was preserved.

An important feature of this splint, of



FIG. 3. Six weeks later the head is displaced downward and there is some bone union, note fracture line extending upward to the crown of the head.

FIG. 4. Twelve weeks later there is bone union and the head is replaced in the fossa.

the femur splint and of splints for other articular fractures is the provision for controlled unirritating movement of the joint.

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# TENDON REPAIR WITH STEEL WIRE

GERALD H. PRATT, M.D.

Assistant Clinical Professor of Surgery, New York Post-Graduate Medical School and Hospital  
New York, New York

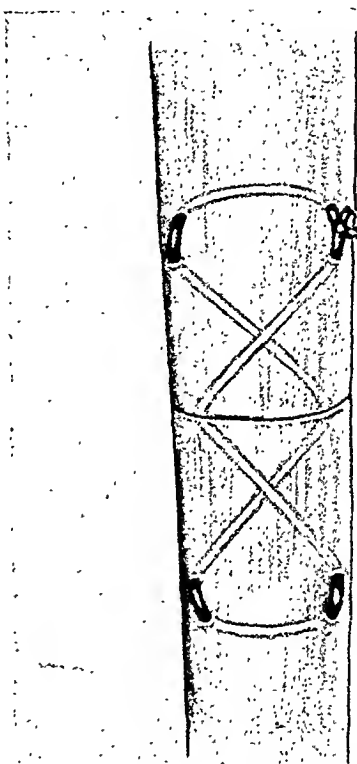
LACERATIONS of tendons are grossly contaminated in most instances. The injury causing the laceration invariably is one causing both gross and microscopic soiling with great infection potentialities. Surgical cleansing and the drugs available to combat infection have reduced serious infections in these patients. Even with these drugs there is considerable local reaction in most instances. This results in many tendon repair failures.

During the recent war, with 60 per cent of wounds occurring in the extremities, many tendon lacerations were seen. In most instances there was so much contamination and such extensive tendon loss that primary repair was not feasible. In these the tendon ends were identified by a silk suture left in either fragment and no primary repair was attempted. Many developed silk sinuses, persisting in a chronically infected state until the suture was removed.

Noting this sinus tendency, the author began using alloy steel wire as an identifying guide instead of silk. It was noted that the steel did not create sinuses and the ends were later identifiable by x-ray or fluoroscopy in many cases in which the wire could not be seen. In some, the foreign body locator (Morehead-Berman) was used for the same purpose.

Later in the war many tendon injuries were primarily repaired with steel wire and the number successfully healed caused the method to be adopted routinely. A fine steel wire (No. 36 or 35) is selected and threaded on minute needles without kinking. Suturing can be done, after the method of Connell, the ends of the suture being cut short on the knot. These sutures are so fine that distortion of the tendon fibers which is seen so frequently when silk is used does not occur. Greater care in

anatomically realigning the ends can be taken. It is gratifying to see the wire suture sink into the tendon substance and in many tendon repairs no suture is visible on the surface after its completion.



Suture inserted without kinking in usual tendon repair method. Wire with its minimal tissue reaction is ideal suture material.

Advantages of such suturing are apparent at once: The steel wire is without tissue reaction or foreign body response and permits healing without the usual serum seen when catgut or other suture materials are employed. The sinuses following silk and at times cotton are eliminated. The peritendinous reaction with scars and adhesions is greatly minimized. The wire in many instances probably remains permanently as a core of strength in the tendon.

This is true especially in the smaller tendons in which some tendon substance was lost.

#### TECHNIC

As we have described steel wire requires a special technic in its use as can be seen in the accompanying illustration. The wire's tensile strength is great but is markedly reduced by injudicious kinking. The suture nurse must be particularly cautious to avoid kinks in preparing sutures. Wire should be kept in hanks or in tubes rather than on spools. We prepare it in long steel tubes which permits boiling without kinking between its preparation and use.

The suture should be "followed" by the assistants' hands to prevent a twist or kink. Tying is best performed by hand rather than with a clamp. By experience a knot can be brought down squarely without a sharp or right angled curve in it. Knots should be tied three times and cut off short. Leaving long ends to be turned down is traumatizing, tends to kink and

by loosening defeats the suture's purpose. In no instance should the suture be drawn tight enough to constrict or strangulate tissue as when the tissues swell in their reaction to the suturing, the steel wire will not give at all and then may cut through. Thus, wounds can be closed by mere close approximation rather than the avascular pressure usually occurring. One cardinal advantage permitted by this technic is the early movement of the part. Movement can be started as soon as the skin is sealed. Splinting is unnecessary after primary healing and passive exercises may be begun at once and active exercises within a week. Tendon adhesions, the cause for most of the disabilities, is kept minimal.

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# PLASTIC REPAIR FOR POSTOPERATIVE ANAL INCONTINENCE\*

MAJOR ROBERT TURELL,† LIEUT. COLONEL JOSEPH B. GORDON AND COLONEL KEMP DAVIS

*Medical Corps, Army of the United States*

THE purpose of this paper is to present the application of the Bunnell<sup>1</sup> type of tendon suture to the successful plastic repair of the anal sphincter muscle. It is taken for granted that the reader is acquainted with the surgical anatomy of and the injuries to the anal sphincter.<sup>2-4</sup> Personal experience coupled with a review of the literature supports the evidence that incontinence is produced when complete section without immediate suture of the external anal sphincter muscles occurs in any but the posterior commissure. The posterior fibrous extension of the external anal sphincter to the coccyx apparently brings about a splinting of the cut muscle ends and thus prevents incontinence.<sup>5</sup> Incontinence usually follows the retraction of the cut ends of the muscle following obstetric procedures or operations upon the anal canal; it occurs most often following inexpertly performed fistulectomy. Frequently, incontinence is the direct result of injudiciously prolonged or tight packing of the wound following section of the sphincter muscle incident to the performance of fistulectomy.

Numerous plastic operative procedures have been proposed although no one surgeon, no matter how extensive the clinical material at his disposal may be, has the opportunity to treat many of these cases because of their relatively infrequent occurrence. Buie<sup>6</sup> advocated a simple plastic procedure which consists of excision of the scar and recreation of the original wound which was present following fistulectomy. With perfect postoperative care, the new wound heals well with resultant continence.

Knapp,<sup>7</sup> in a selected case of incontinence, utilized the superficial transverse perineal muscle for a successful repair. Stone and McLanahan<sup>8</sup> are strong advocates of the Vreden procedure<sup>9</sup> which utilizes two fascial strings that are anchored to the glutei maximi to encircle the anal canal. Blaisdell<sup>10</sup> utilized a procedure which consists of isolating and reefing the external anal sphincter muscles thus decreasing the circumference of the whole muscle and anal outlet. David<sup>5</sup> illustrated an operative technic which essentially consists of excision of the scar between the severed ends of the sphincter muscle and their reunion with mattress sutures.

The authors' present surgical plan is to attempt the restoration of the continuity of the external anal sphincter muscle by excising the intervening and adjacent scar and reapproximating the freshened muscle ends as illustrated in the accompanying drawing (Fig. 1) which is based on sketches made during the course of the operation. In the case illustrated here the muscle ends were reunited by means of a Bunnell-like stitch (Fig. 1 c and d) which is used in successful repair of the severed tendons. This stitch was chosen because it appears to avoid strangulation of tissues involved in the sutures. Prior to the tying of this muscle suture, a few interrupted sutures are introduced into the tissues under the muscle which obliterate any possible dead space and incidentally take off the tension on the sphincter muscle stitch. (Fig. 1 c.) The subcutaneous tissues are approximated with interrupted sutures and the skin is left unsutured. No. 0

\* From The Surgical Service, Letterman General Hospital, San Francisco, Calif.

† Now in civilian practice, New York, N. Y.



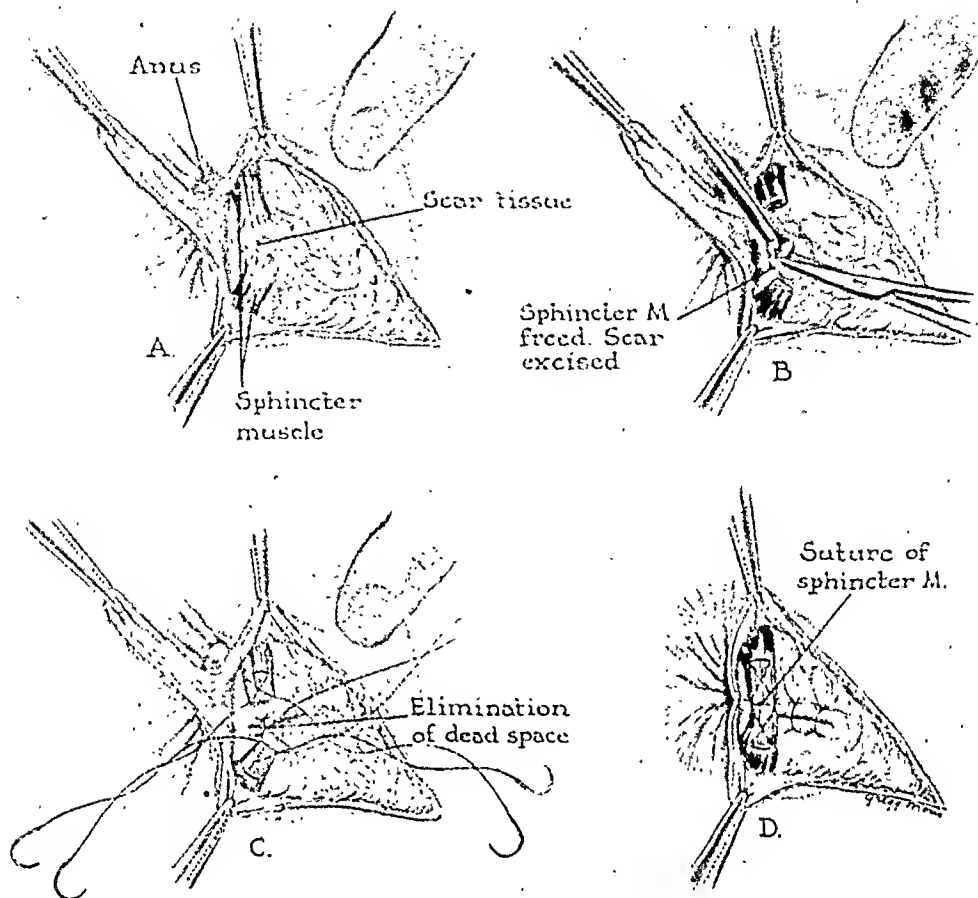


FIG. 1. A, appearance of lesion at operation; B, muscle ends freed, scar excised; C, one needle with suture is passed transversely through belly of muscle about 0.75 cm. from severed end and then each needle is traversed obliquely within the muscle substance so as to emerge on the side at the edge of each severed end. The suture strands at each muscle end are then tied; D, muscle ends approximated cleanly by tying the suture strands.

chromic catgut on an atraumatic needle is used throughout the procedure. Sulfone and antibiotic therapy is employed before and after operation.

This type of stitch has also been employed by one of us (R. T.) for suture of the sphincter muscle following excision of a deep anal fistulous tract which necessitated severance of the deep component of the external anal sphincter muscle. Union of the severed ends of the sphincter muscle was easily effected with resultant perfect continence.

#### SUMMARY

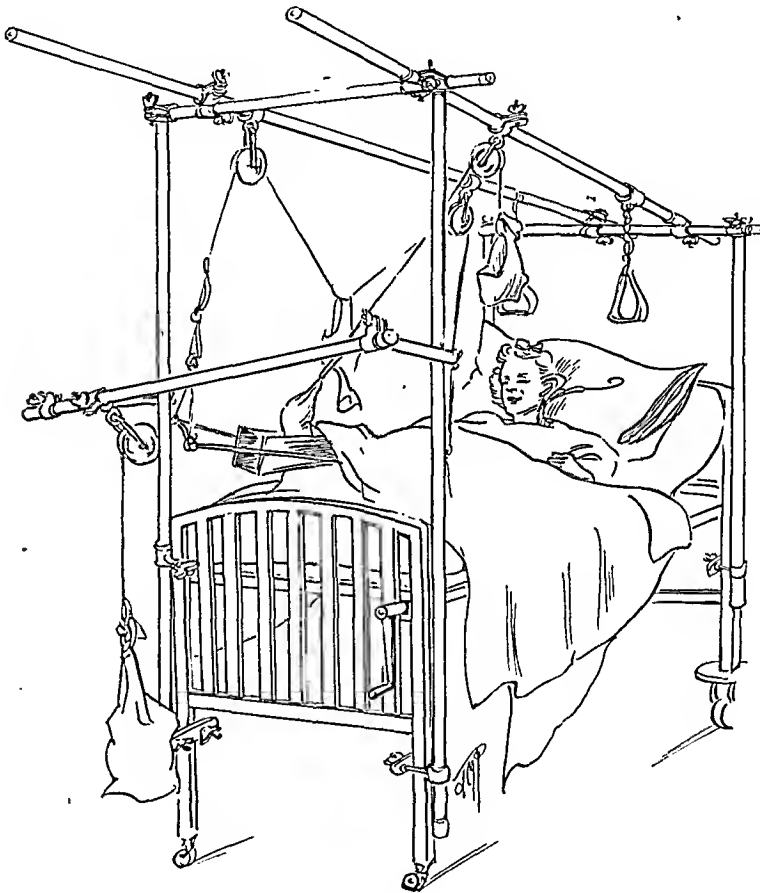
Utilization of the Bunnell type of tendon suture in the repair of severed anal sphincter muscle for successful restoration of continence is recorded and illustrated. This stitch appears to avoid strangulation of muscle fibers involved in the sutures.

*Acknowledgment:* We are indebted to our artist, Gregg Moris, for the drawings.

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# Case Reports

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## MULTIPLE DUPLICATIVE CYSTS OF THE DUODENUM CAUSING ACUTE INTESTINAL OBSTRUCTION IN A GIRL FIVE AND ONE-HALF YEARS OF AGE\*

N. FREDERICK HICKEN M.D., VERNON L. STEVENSON M.D., JOHN H. CARLQUIST, M.D. AND  
Q. B. CORAY, M.D.  
*Salt Lake City, Utah*

CONGENITAL duplications of the duodenum can produce cystic tumors of such size that a compressive occlusion of the duodenal lumen may result. These pathologic curiosities are very rare as the literature contains records of but nine other cases. An early diagnosis combined with prompt surgical intervention affords the only opportunity for survival.

### CASE REPORT

E. M. a girl five and one-half years of age was admitted to the Latter Day Saints Hospital because of persistent vomiting associated with epigastric distress. The initial attack of indigestion occurred when she was but eleven months of age, and since that time they have increased in severity and frequency. During the intervals between each exacerbation she was free from distress and was able to assimilate all types of food. Her physician thought she suffered from a hypertrophic pyloric stenosis which he attempted to control by selected diets and antispasmodic medication. During the past year, however, she has been intolerant of all solid foods and has eaten commercially prepared food for babies. Her present attack began two weeks prior to admission. The uncontrolled vomiting of all ingested foods and fluids soon resulted in dehydration, emaciation and prostration.

Physical examination showed the child to be extremely ill, suffering from an advanced state of dehydration, acidosis and anemia. The

stomach was distended while the lower intestinal tract appeared to be collapsed. Peristaltic waves were seen to originate in the upper end of the stomach and travel downward and toward the right where they ended abruptly at the pylorus. Colonic flushings contained bile-stained mucus devoid of food particles.

Palpitory examination outlined two golf ball-sized tumors lying just above the umbilicus. They were smooth, firm and seemed to be attached to the posterior abdominal wall. The two ovoid masses were adherent to each other as manipulation of one tumor produced a similar motion in its neighbor. There was no detectable enlargement of the regional or distant lymph nodes.

A scout film of the abdomen revealed the stomach to be greatly distended with gas while the duodenum, ileum and colon were all collapsed. On fluoroscopic studies the ingested barium was seen to fill the distended stomach and then pass into a dilated, crescent-shaped duodenal cap. None of the barium, however, voluntarily passed along the duodenum unless direct pressure was exerted on the stomach. Fluoroscopically we were able to follow the thin string of the contrast medium as it was forced along the attenuated but displaced duodenum. (Fig. 1.) Apparently the expanding tumors had pushed the duodenum upward and outward thereby causing a pressure occlusion of its lumen. These findings suggested the diagnosis of "multiple retro-peritoneal tumors producing a duodenal obstruction by exerting extrinsic pressure." We thought we were dealing with a retroperitoneal lymphoblastoma.

\* From the Surgical, Pathological and Roentgenological Services of the University of Utah Medical School and The Latter Day Saints Hospital, Salt Lake City, Utah.

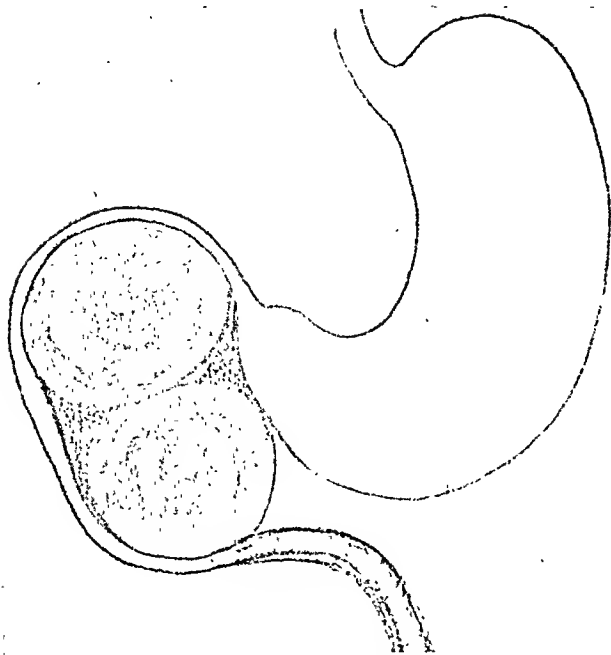


FIG. 1. X-ray taken ten hours after ingestion of barium. Note the marked gastric retention and the displaced, crescent-shaped, dilated duodenal cap. The descending and transverse segments of the duodenum are not visualized. Some of the barium, which was manually expressed through the displaced but patent duodenum, can be seen in the lower ileum and colon. Diagnosis: An expanding, retroperitoneal tumor producing duodenal obstruction by extrinsic pressure.

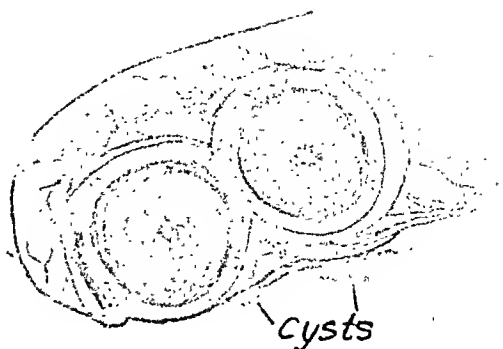
After five days of careful preoperative preparation, consisting of continuous gastric decompression combined with the administration of whole blood, adequate electrolytes, amino acids and vitamins, the abdomen was opened. The obstruction at the outlet of the stomach was caused by two golf ball-sized tumors lying between the leaves of the gastroduodenal ligament. These spheroid masses were contiguous but not confluent and they lay in such a position that one of them was intimately fused with the mesial wall of the descending duodenum and the other one with the upper wall of the transverse segment. (Fig. 2.) On examination it was found that the serosal,

muscular and vascular components of the duodenal wall fanned out over the tumors and completely invested them. (Fig. 3.) They were smooth, firm and devoid of inflammatory reactions. Apparently during their growth these expanding tumors had displaced the duodenum and so compressed its lumen that an acute gastric retention resulted.

Where did these extragastric neoplasms originate? Were we dealing with mesenteric cysts, pancreatic cysts, adenomas of the pancreas, diverticula of the duodenum, lymphblastomas or enterogenous cysts? In order to obtain more information concerning the structure of these neoplasms each mass was explored with a



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FIG. 2. A drawing showing the anatomic location of the two duodenal cysts and the manner in which they effected an acute obstruction by compressing and displacing the first, second and third portions of the duodenum.

FIG. 3. A schematic drawing showing how the serosal and muscular coats of the duodenum spread out and invest these cysts. Note the small size of the duodenal lumen.



FIG. 4. The exact anatomic position of these two cystic tumors was obtained by aspirating their cystic contents and introducing an equal volume of 70 per cent diodrast. X-rays which were taken on the operating table reveal the two cysts to be contiguous but not confluent. They did not communicate with the gastrointestinal tract.

No. 16 gauged needle. Surprisingly, one tumor contained 32 cc. of a turbid, acholic, mucoid fluid and the most mesially placed cysts held

27 cc. of the same material. Microscopic and chemical examination of the aspirated fluids failed to demonstrate the presence of lymph, bile or pancreatic secretions hence we concluded that we were dealing with an enterogenous cyst.

What were the anatomic relations of these two cysts to the duodenum and stomach? This question was answered by injecting 30 cc. of a solution of 70 per cent diodrast into each cyst and having an x-ray film made on the operating table. (Fig. 4.) This visualizing roentgenogram demonstrated the two cysts to be contiguous but not confluent with nor did they communicate with the gastrointestinal tract. These findings were incompatible with the diagnosis of diverticula of the stomach or duodenum. It was evident that we were dealing with congenital duplicative cysts arising from the duodenal wall.

The gastroduodenal ligament was opened and the most mesially placed cyst was readily enucleated from its intraligamentous bed. The cyst lying contiguous to the duodenum, however, presented a more tantalizing problem. Apparently it had originated within the walls of the duodenum for the serosal and muscular portion of the gut completely encased the cyst. Resection of the descending limb of the duodenum and its cystic counterpart was out of the

question as this would have required division and transplantation of the choledochal and pancreatic ducts, an operation that was much too formidable for this malnourished youngster. Therefore, the cyst was opened and its mucosal lining was removed by sharp dissection. Fortunately the duodenal mucosa was not perforated during this procedure. The muscular coats of the cyst, which were really a part of the duodenum itself, were imbricated over each in such a manner as to reinforce the weak mesial wall of the duodenum and thus preclude the development of a pressure diverticulum.

The patency of the duodenal lumen was confirmed by manually expressing the gastric contents along the intestinal tube. There seemed to be no indication for gastrojejunostomy so the abdomen was closed.

During the next five days progressive vomiting indicated that the acute obstruction had not been relieved; therefore, the abdomen was reopened. It was found that the primary operation had produced so much edema and swelling of the periduodenal tissues that the attenuated lumen had again become occluded by extrinsic pressure. In order to relieve the acute gastric retention posterior gastrojejunostomy was done and the patient made a rapid recovery. It has been twenty-three months since her operation and she has been free from digestive disturbances.

Dr. Carlquist examined the tissues and submitted the following report: "The surgical specimens consisted of two cysts, each of which had a diameter of 3.5 cm. They were both collapsed, having been opened on the operating table. The cyst which was adjacent to the duodenum had lost a portion of the serosal and muscular layers as they had been left attached to the duodenum. The wall of the cyst measured 0.6 cm. in thickness and presented a whitish-yellow color. It was lined with a velvety mucosa. Microscopic sections of the cyst wall were stained with hematoxylin, eosin and trichrome stains. The mucosa, submucosa, and muscularis were easily recognized and resembled that of the normal duodenum. The serosa blended with the adjacent fibrous tissues. The walls showed no evidence of inflammation but were somewhat thicker than the normal duodenum.

"The wall of the second cyst measured 0.2 cm. in thickness. It presented a yellowish color but did not seem to be lined with mucosa.

Histologically the wall was made up of fibrous tissue which was moderately vascular and contained a few lymphocytes. No smooth muscle could be recognized. The lining did not present any epithelial structures but consisted of a condensation of the underlying fibrous stroma. There was nothing to indicate the origin of this cyst.

"It is evident that the first cyst originated in the duodenum and represented a duplication of that viscus. The nature of the second cyst was more difficult to determine but its proximity to the duodenal cyst would suggest a common embryological origin."

#### COMMENTS

Confusing terms are often used to describe these duplicative aberrations of the duodenum. Some authors refer to them as "enteric cysts," "enterogenous cysts," "inclusion cysts of the intestines," "gastrogenic cysts," "giant duodenal diverticulum," "duplications of the alimentary tract," "Unusual Meckels diverticulum" and "mesenteric cysts." Ladd and Gross<sup>3</sup> suggest that a term such as "duplications of the alimentary tract" be employed to embrace all congenital malformations regardless of the segment of the intestinal tract from which they arise. Descriptive phrases such as "ileum duplex," "stomach duplex" or "duodenum duplex" could be applied to particular lesions. This plan is certainly rational.

According to the theories advanced by Lewis and Thyng,<sup>4</sup> these duplicative cysts arise as diverticular pockets within the wall of the primordial duodenum. As a rule these small pouches regress as the duodenum develops but occasionally they may persist. Being lined with intestinal mucosa the cyst gradually expands because of accumulated secretions. As it expands the cyst carries with it the serosal and muscular layers of the parent duodenum. Thus these congenital cysts are not contiguous to the duodenum but are actually a part of it. It is evident that the expanding cyst could and does produce a compressive occlusion of the duodenal lumen.

The type of fluid which these cysts contain varies. In simple uncomplicated cases it may be clear and colorless. If the intracystic pressure becomes too great or if the cyst becomes too large, it may produce a pressure occlusion of the blood vessels

duodenal obstruction was complete, the child may not survive the trauma of birth. If, however, the expanding cyst does not completely obstruct the duodenum the recurring attacks of vomiting may be mistaken for those accompanying hyper-

TABLE 1

Author	Age	Preoperative Diagnosis	Pathologic Findings	Operative Procedures	Results
Sanger.....	Stillbirth	None	1 duodenal, 3 ileal and 1 choledochal cysts	None	Stillbirth
Roth.....	Stillbirth	None	1 duodenal cyst 1 esophageal cyst	None	Stillbirth
Meyers.....	3 wk. girl	Pyloric stenosis	1 duodenal cyst	None	Died
Maddox.....	3 mo.	Pylorospasm	1 duodenal cyst	None	Died
Smith.....	?	Pyloric stenosis	1 duodenal cyst	None	Died
Waugh.....	19 days girl	Congenital atresia	1 duodenal cyst	Aspiration cyst gastroenterostomy	Died
Basman.....	4½ yr. girl	Pyloric stenosis	1 duodenal cyst	Aspiration of cyst only	Recovered
Gardner Hart....	15 yr. girl	Pyloric stenosis	1 duodenal cyst	Removed septum making duodenal diverticulum	Recovered
Ladd and Gross...	5 wk. girl	Congenital atresia	1 duodenal cyst	Resection cyst and duodenum, gastroenterostomy	Recovered
Hicken and Stevenson	5 yr. girl	Lymphoblastoma	2 duodenal cysts	Excision of one cyst obliteration one cyst gastrojejunostomy	Recovered

within the walls of the cyst thereby causing the mucous membrane to undergo necrotizing and gangrenous changes. In such an event the aspirated fluid may be hemorrhagic. Should there be a communication with the duodenum the large diverticulum would contain food and digestive secretions.

#### SYMPTOMS

It is interesting to note that in the nine reported cases not a single one was recognized before surgical or postmortem examinations were made. (Table 1.) This means that duplicative cysts do not produce characterizing symptoms but rather mimic those seen in other forms of acute or chronic intestinal obstruction, nausea, vomiting, dehydration, acidosis and inanition progressively develop. The severity of the symptoms is directly proportional to the degree of duodenal obstruction.<sup>9</sup> Sanger,<sup>8</sup> and later Roth,<sup>7</sup> pointed out that if the

trophic pyloric stenosis,<sup>1</sup> pylorospasms<sup>5</sup> or partial atresia of the intestinal tract.<sup>10</sup> Gardner and Hart<sup>2</sup> found that their fifteen year old girl suffered paroxysms of vomiting, having periods of almost complete relief between exacerbations.

Pain is not a prominent symptom. It occurs when the cyst becomes distended with retained secretions or from intracystic hemorrhages. The pain is persistent and is not relieved by vomiting as often occurs with hypertrophic pyloric stenosis.

It must be remembered that associated embryologic defects may distort the clinical picture. Roth<sup>7</sup> encountered duplicative cysts affecting both the duodenum and esophagus. Sanger<sup>8</sup> reported a stillborn child that had multiple duplicative cysts; one in the duodenum, three in the ileum and one affecting the common bile duct.

Physical examination discloses the upper abdomen to be distended with gas while the

lower portion is collapsed. Peristaltic waves can be seen to pass from the left side of the abdomen to the right where they end abruptly at the pylorus. Intestinal activity is usually diminished. Suctional decompression of the stomach immediately relieves the abdominal distention thereby disclosing a firm, semifixed mass lying just above and to the right of the umbilicus. The tumor may assume an ovoid or tubular conformation and usually ranges in size from a walnut to that of a lemon. It is impossible to alter the size, shape or position of the cyst by either direct pressure or by gastric decompression because there is no communication with the duodenal lumen. Such manipulations cause a duodenal diverticulum to collapse. It is also well to remember that these cystic tumors are much larger than any tumefaction associated with hypertrophy of the pyloric ring.

Roentgenologic studies afford the only method of making an accurate preoperative diagnosis. The scout films usually localize the obstruction in the duodenum by outlining the distended, gas-filled stomach while small intestines and colon harbor but little gas. Peristaltic waves are seen to originate in the stomach and end abruptly at the obstruction. Fluoroscopic studies are particularly informative as the ingested barium can be seen to traverse the attenuated but displaced duodenum. As the cyst lies in the gastroduodenal ligament it pushes the duodenum upward and outward thereby widening the "U" shaped appearance of the duodenal loop. The fact that the tumor is periduodenal immediately precludes the possibility of this mass representing a hypertrophied pyloric ring. Duodenal diverticula may occupy the same position as do these duplicative cysts but the former always communicate with the intestinal lumen and hence become filled with the contrast medium. Partial atresia results in a narrowed duodenal lumen which occupies a normal anatomic position and is not rotated, compressed or dislocated by adjacent tumefactions.

#### TREATMENT

These duplicative duodenal cysts are definitely surgical problems. The primary consideration is to relieve the acute intestinal obstruction. Selection of the remedial operations depend on the size and location of the enterogenous cyst, and the severity and duration of the obstruction. Ladd and Gross<sup>3</sup> believe that resection of the duplication cyst and contiguous duodenum, combined with a posterior gastrojejunostomy, affords the best prognosis. Unfortunately such a plan is not always practical. In our case it would have been necessary to remove the two cysts, resect the descending and transverse portions of the duodenum and implant the choledochus and pancreatic ducts into the jejunum. Obviously, such extensive operations are not well borne by these frail youngsters.

Gardner and Hart<sup>2</sup> suggest that the septum which separates the duplicative cyst from the duodenum should be excised. This would permit the cystic fluids to drain into the duodenal lumen thus relieving the acute obstruction. In our patient such an operation would have been impractical as the resulting diverticulum would have been so large that the retention of ingested goods might there provoke undesirable symptoms. Gardner and Hart<sup>2</sup> experienced this complication in their own case.

When dealing with frail babies, simple gastrojejunostomy will provide respite from the acute duodenal obstruction thereby permitting prompt alimentation. Such a procedure, however, leaves the expanding cyst *in situ* so added growth will most certainly effect another obstructive reaction. Waugh<sup>10</sup> attempted to circumvent this difficulty by aspirating the fluid from the cyst and then anchoring the collapsed cyst to the anterior abdominal wall. Two weeks were required for the cyst to refill and produce a secondary obstruction. He reoperated upon the patient and marsupialized the cyst so that it could drain externally; unfortunately the patient succumbed.



It occurred to us that a refilling of the collapsed cyst could readily be prevented by removing its secreting mucosal lining. This would eliminate the necessity for extensive resections and at the same time prevent reformations of the cyst. Such a plan has the additional value of utilizing the muscular and serosal layers of the cyst for reinforcement of the weak mesial wall of the duodenum thereby minimizing the formation of a duodenal diverticula. Our experiences dictates, however, that this plastic operation should have a complementary, posterior gastrojejunostomy.

#### SUMMARY

Congenital duplications can affect any portion of the alimentary tract. If the mucosal component of the resulting cyst becomes active, the retained secretions produce a cystic tumefaction which can obstruct the parent structure by exerting extrinsic pressure. The duodenum is seldom affected by these congenital duplications as only nine cases have been reported in the literature. The case herein reported is that of a girl, five and one-half years of age, who had two duplicative cysts of the duodenum which produced a compressive obstruction of the descending and transverse duodenal segments.

These duplicative cysts present the clinical picture of acute duodenal obstruction. They closely mimic the symptoms of hypertrophic pyloric stenosis, pylorospasms, diverticula and atresias of the duodenum. An accurate diagnosis can always be made by adequate roentgenologic studies. The obstructed duodenum will appear to be rotated, displaced and compressed by an extrinsic tumor mass.

Remedial surgery affords the only opportunity for survival. Resection of the duodenum and its contiguous cyst combined with posterior gastrojejunostomy

can be employed in special cases. If the enterogenous cyst is small, the mucosal lining which separates it from the duodenal lumen can be removed thus permitting the cystic fluid to drain into the intestinal tract. There is no assurance, however, that the newly formed duodenal diverticulum will not produce annoying symptoms. In our case the mesially placed cyst was completely removed while the one lying adjacent to the duodenum was opened, its mucosal lining completely removed, and its walls were utilized to reinforce the congenitally weak walls of the involved duodenum. Such operations should be combined with posterior gastro-enterostomy.

A complete study of the embryology, anatomy, symptomatology, diagnosis and treatment of this unusual congenital deformity is presented.

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# EMBRYOMA OF THE TESTICLE IN A FIVE-YEAR OLD CHILD\*

HERMAN L. KRETSCHMER, M.D.

*Chicago, Illinois*

**T**UMORS of the testicle are extremely rare in children. The literature on this subject is comprised principally of individual case reports. There is no uniformity of opinion in pathologic interpretation of tissues and pathologists differ as to the nomenclature of tumors of the testicle. The same type of tumor may be classified differently by pathologists. There is always the possibility of misinterpretation and wrong diagnosis. The writer has had such an experience. Therefore, the number of cases reported may not be a true representation because of wrong diagnosis, particularly any statistical study covering cases reported in the older literature.

Dean in 1935 made a clinical study of 292 patients with testicular teratoma. In this group there were three cases occurring in children from zero to five years, two in five to ten years and one in ten to fifteen years.

Matassarini in 1944 reported a personal case of an embryonal adenocarcinoma in an infant seven months of age. He also states that he had a personal communication from Dr. Judson B. Gilbert, of Schenectady, New York, who had reviewed the literature from 1803 to 1942. Dr. Gilbert found some interesting statistics. Out of 5,500 cases of all tumors of the testicle that had been reported in full detail, only 131 were in children under the age of fifteen. Of these 131 cases forty-two were dermoids and eighty-nine teratomas. Of the eighty-nine teratomas only seventeen were in children of one year of age or under.

From January 1, 1934, through December 31, 1946, there were 160,275 admissions to the Presbyterian Hospital in Chicago.

Of this number 124,622 were adults, 22,027 children up to the age of fourteen and 13,626 were newborn. Among the adults there were 43 cases of various types of tumors of the testicle. During this period only one case of tumor of the testicle in a child was admitted to the Presbyterian Hospital and that case is the one reported in this paper. Therefore, the case reported here makes an incidence of one in 35,653 children and newborn or, if we exclude the newborn, one in 22,027 cases.

The following case is reported primarily to put on record a case of embryoma of the testicle in a boy five years of age.

## CASE REPORT

J. W., aged five, was referred by Dr. Craig Butler and was admitted to Presbyterian Hospital on June 20, 1946, with an enlargement of the right testis. The mother stated that one month before, while bathing him, she noticed that the right testis was much larger than the left. The mother believed that there had been no increase in the size during that month. There was no pain and no tenderness and no history of injury. The child had had chickenpox and pneumonia, tonsillectomy and adenoidectomy had been performed at the age of three years.

Physical examination revealed the head, neck, nose, eyes and ears to be normal. The pharynx showed a mild injection. X-rays of the heart and lungs and examination of the abdomen were negative. The right half of the scrotum showed the right testis to be enlarged and hard. The enlargement measured 4 cm. by 2½ cm.; the left testis measured 1 cm. by ¾ cm., and the skin had a bluish discoloration. Blood pressure was 102/60; pulse rate was 100. The Kahn and Aschheim-Zondek tests and urinalysis were negative. Blood count and smears were normal.

\* From the Presbyterian Hospital, Chicago, Ill.



FIG. 1. Embryoma of testis.

On June 24, 1946, a right orchiectomy was performed. The cord was immediately isolated at the internal ring and divided between two clamps. Carbolic acid (95 per cent) was applied to the divided ends of the cord. The dissection was continued downward, the cord was freed and the testicle isolated and removed. It was noted that the veins along the cord were rather large for a small child.

The child made a smooth and uneventful convalescence and was discharged from the hospital on July 1, 1946.

The pathologic report by Dr. George Hass on June 23, 1946, was as follows: The gross specimen (Fig. 1) consisted of fresh tissue labeled testicle. The specimen weighed 30 Gm. and consisted of the testicle, epididymis and 7 cm. of the cord. The testicle had been opened lengthwise. Its outer covering was light gray and smooth. The cut surface was of a slight



FIG. 2. Tubules separated by diffuse infiltration of small cells.

yellowish tinge and waxy in consistency. The epididymis was pale pink, soft and was normal. The cord did not present any noteworthy changes. The testicle measured 5 cm. in length and after being opened had a diameter of 3 cm.

The sections showed a very interesting type of histology. Immature tubules of the testis were separated by a diffuse infiltration of small cells. (Fig. 2.) The small cells showed a polyhedral tendency. They were not distinct from one another and did not tend toward the formation of glandular spaces. Mitotic figures were very rare. The cells were about the same size as lymphocytes or lymphoblasts. In fact, the type of infiltration was strongly suggestive of the infiltration found in certain types of lymphoblastoma or lymphocytic leukemia.

These small cells were of the type found in embryomas. They are common in embryomas of the kidney and also are found often in the embryonal tumors of the testes. Apparently there was but a single type of cell involved in this tumor. There was nothing of a mixed ele-

ment such as is common in teratomas. The pathologist believed that irradiation should be the course followed in this case. The prognosis in the case of any solid tumor of infancy and childhood is, of course, very poor, irrespective of the apparent slowness of the rate of growth of the solid tumor. The rate of growth seemed to be so slow and the tumor so well circumscribed and limited to the testis that the pathologist leaned toward a favorable prognosis.

*Diagnosis:* Embryoma of the testis. (Fig. 3.)

On June 24, 1946, several additional blocks of tissue were taken for the purpose of studying the epididymis and the spermatic cord. The sections showed that the tumor seemed to be fairly well restricted to the testis. There was no involvement of the epididymis. In fact, there was not as much of the structure of the epididymis as there should be. Dissection at various levels along the spermatic cord showed a few small cells around lymphocytic spaces. These did not appear to be of the same type as the cells found in the tumor of the testis. There were a few tubular vestigial structures of embryonic origin along the course of the spermatic cord which were benign in character.

From June 29th to July 11, 1946, the patient was treated through two areas of the spine posteriorly to cover the aortic glands, the lower area covered from the sacrum to about the mid-lumbar region, and the upper area covered from the middle lumbar region up to approximately the ninth dorsal vertebra. Each area was given a total of 1,000 r in divided doses of 200 r so that each area was treated on alternate days. The factors used were: 18 ma.,

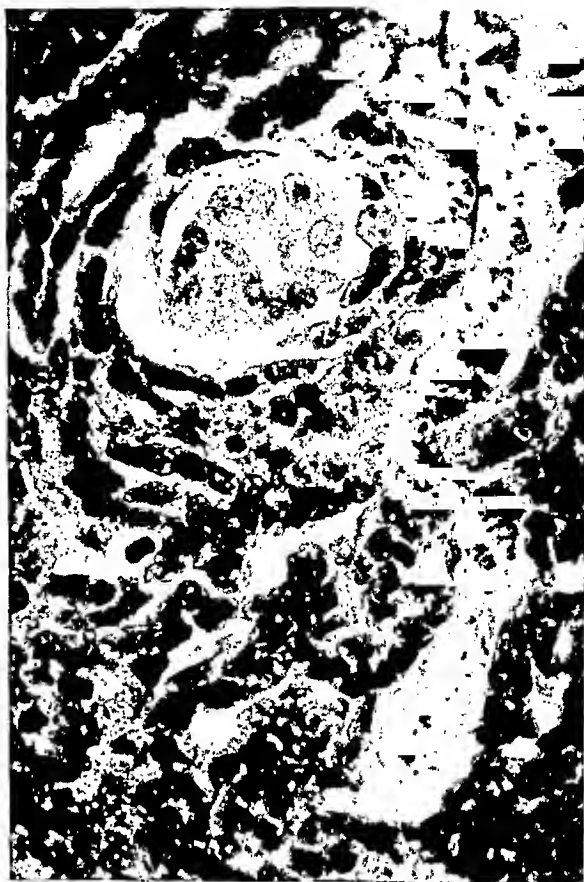
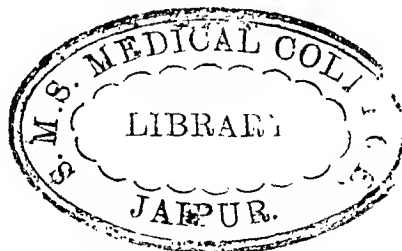


FIG. 3. High power microphotograph of embryoma of testis.

200 KV, 500 cm. distance,  $\frac{1}{2}$  mm. Cu, 1 mm. Al filter.

An examination by Dr. Craig Butler on November 15, 1947, was entirely negative. There were no signs of local recurrence nor of metastases.



# PIA-ARACHNOIDAL CYSTS OF THE POSTERIOR FOSSA\*

ABRAHAM KAPLAN, M.D.

*New York, New York*

**P**IA-ARACHNOIDAL cysts found in the midline posterior fossa are indeed rare. A thorough search of the literature has revealed only three similar cases, (Cases 1 and 2) reported by Craig<sup>1</sup> under the title of Chronic Cystic Arachnoiditis, and one recent case report by Thompson<sup>2</sup> under the heading of Cystic Cerebellar Arachnoiditis. To these three cases the following two are added:

## CASE REPORTS

**CASE 1.** M. R., a certified public accountant, aged thirty-two, was admitted to Mount Sinai Hospital on January 18, 1937, because of headaches, vomiting and failing vision. The past and personal history were non-contributory. There was no episode of infection or trauma. For five or six years before admission at irregular intervals he experienced morning vomiting shortly after awakening. At times the vomiting was projectile and often was associated with transient suboccipital headache. He was treated for a variety of "stomach ailments" by different specialists but repeated x-ray studies of the intestinal tract and gall-bladder failed to establish any abnormal findings. He was symptom-free for months at a time.

Five months before admission, while crossing the street, he noted the sudden onset of diplopia which lasted only for about two minutes. From then on similar episodes of diplopia recurred at least four or five times weekly. His wife observed dilatation of both pupils. Four months before admission he noted unsteadiness in gait with a tendency to stagger to either side but more so to the left. The ataxic gait was more pronounced in the dark. He had no difficulty in performing skilled acts. With excitement he would develop attacks of thumping headache and vertigo which were frequently accompanied by numbness of the fingers of both hands. Difficulty in swallowing, choking sensations and regurgitation through the nose set in

two months before admission. There was a mild diminution of libido for a year. When papilledema was discovered, he was promptly admitted to the hospital.

Examination showed a frail, bright, young man with slight bilateral exophthalmos which he stated had been present since childhood. Blood pressure was systolic 102, diastolic 70. He walked with a broad base showing a tendency to retropulsion and veering to the left. The Romberg test was positive. The pupils were dilated, vision was 20/30 in both eyes and the fundi showed acute bilateral papilledema of 3 diopters with dilated and tortuous vessels and numerous small flame-shaped hemorrhages. The blind spots were enlarged but there was no visual field defect. There was horizontal nystagmus in both directions with ataxia in finger to nose test and heel to knee test on the left and dysdiadokokinesia of the left arm. The Babinski reflex was positive on both sides; abdominal responses were absent. X-ray studies of the skull showed no abnormality. Spinal fluid was clear and colorless under 200 mm. of pressure with no cells and with negative Pandy test; the Kalin test was also negative.

On January 25, 1937, a suboccipital craniotomy was done under local novocain anesthesia. The right lateral ventricle was found dilated. As the cerebellar dura was opened, a midline translucent cyst measuring 3 by 4 cm. with one small branching artery and vein coursing over its surface came into view. (Fig. 1.) The cyst wall had the appearance of an arachnoid. One could readily look through the cyst and see that the vermis was compressed and flattened anteriorly and that both cerebellar hemispheres were markedly displaced laterally from the midline. The medulla appeared flattened. The cyst was aspirated and 30 cc. of clear fluid was obtained. The surface vessels of the arachnoidal cyst were clipped and cut. A small pool of clear fluid separated the anterior portion of the cyst from the roof of the fourth ventricle. The fourth ventricle was dilated and, when opened, one could look up into the dilated aqueduct of

\* From the Neurosurgical and Neurological Services of The Mount Sinai Hospital, New York, N. Y.

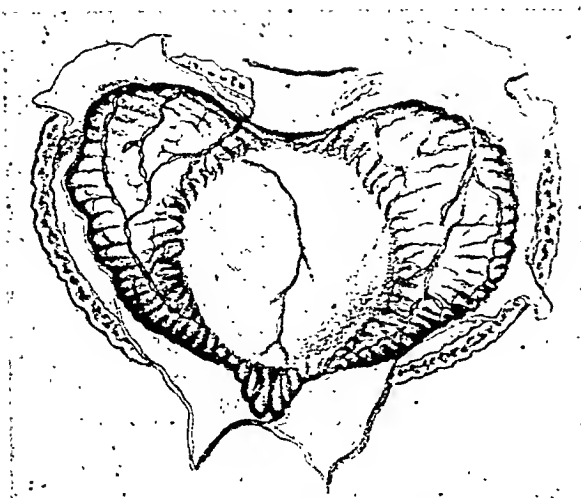


FIG. 1. Case I, operative sketch of midline arachnoid cyst.

Sylvius. There was no evidence of neoplasm or inflammation to be found anywhere in the entire operative field. The wound was closed in the usual manner after removal of the membrane of the arachnoid cyst.

The postoperative course was unusually smooth. The papilledema subsided completely in short course, nystagmus was minimal and the spinal fluid pressure was only 60 mm.

The pathologic specimen was reported by Dr. J. Globus as showing cells simulating arachnoid. There were two layers of cellular groups between which there were fibrous partitions and thin-walled blood vessels. There were no inflammatory or neoplastic elements.

It is now eleven years since this man's operation and during this period he has been in excellent health, very progressive in his business of public accounting and shows not the slightest sign or symptom which had troubled him for six years before the operation.

CASE II. R. A., a thirty-seven year old, married woman, was admitted to the hospital on July 10, 1946, because of headaches and impaired vision in the left eye. For over ten years she noted an increase in weight from 160 to 248 pounds. Since August, 1945, she followed a strict diet and lost 30 pounds in weight. The past and personal history were otherwise non-contributory. Five months before admission she began to have right parietal headaches associated with blurring vision in the left eye. For three months she had bouts of nausea and vomiting occurring about every other day; at times vomiting was projectile. Pain, tearing and blurring vision in the left eye increased



FIG. 2. Case II, dilatation of lateral ventricles with encroachment of right ventricle to the left.

steadily for two months. One month before admission an upper left wisdom tooth was extracted under local novocain anesthesia and this was followed by numbness of the left cheek. For two months upon awakening she would feel a stiffness of the back of the neck. About this time she became unsteady in her gait with a tendency to veer to the right.

Examination showed an obese, alert, cooperative woman in no great distress. The left pupil was larger than the right, the fundi showed acute bilateral papilledema with tortuous veins and arteries and many flame-shaped hemorrhages. Vision of the left eye was 15/100, of the right 15/20. The blind spots were enlarged bilaterally with generalized peripheral constriction but with no visual field defect. Over the left cheek in the area supplied by the second division of the left trigeminal nerve there was a marked hypalgcsia. There was a suggestive right facial weakness and hearing on the left was somewhat diminished. There was no Romberg, ataxia or any other abnormal reflex.

The laboratory studies were as follows: Urine and blood studies were normal; Kahn test negative; blood pressure systolic 126, diastolic

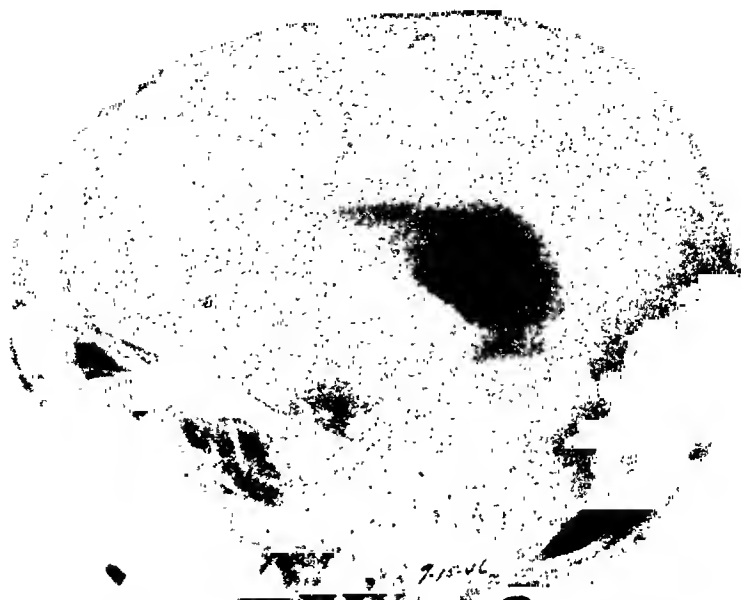


FIG. 3. Case 11, showing obstruction at the lower end of the fourth ventricle with dilatation of lateral and third ventricles above this point.

100; blood sugar 101 mg. per cent; urea nitrogen 9.1 mg. per cent. X-ray studies of the skull showed some atrophic changes in the dorsum and clinoids of the sella turcica. Electroencephalograms gave evidence of a diffuse disturbance. Ventriculography showed marked dilatation of both lateral ventricles with encroachment of the right ventricle toward the left. (Fig. 2.) The third ventricle, aqueduct of Sylvius and upper portion of the fourth ventricle were dilated. (Fig. 3.) The obstruction was at the lower end of the fourth ventricle. Studies of the ventricular fluid showed no cells, negative Pandy test and negative Wassermann reaction. Total protein was 11 mg. per cent.

On July 15, 1946, a suboccipital craniotomy was done. In addition the arch of the atlas was removed. When the dura was opened, a mid-line bluish cyst measuring  $3\frac{1}{2}$  by 4 cm. with fine vessels traversing over its surface in the longitudinal diameter came into view. One could see through this cyst the anteriorly compressed vermis and the lateral displacement of both cerebellar hemispheres. The cerebellar tonsils were partially herniated through the foramen magnum. Aspiration of the cyst yielded 20 cc. of clear fluid. After the surface vessels were coagulated, the cyst was opened and another fine, transparent membrane covering the roof of the fourth ventricle came into

view. At the lowermost portion of the cyst there was a small opening through which clear fluid escaped from the fourth ventricle. The entire cyst membrane was then stripped away exposing a markedly dilated, diamond-shaped fourth ventricle at the upper end of which one could see the dilated orifice of the lower end of the aqueduct of Sylvius. A specimen of the cyst wall was taken for study. Investigation of the entire operative field, including the cerebello-pontile angles and upper portion of the cervical canal, showed no evidence of neoplasm or inflammation.

The postoperative course was smooth and most gratifying. The papilledema subsided rapidly, headaches and vomiting disappeared completely and within a fortnight she was walking without the slightest unsteadiness. Vision in the left eye improved from 15/100 to 15/70, the blind spots decreased in size and the peripheral fields ballooned out.

Pathologic study of the cyst wall (Fig. 4) showed dense hyalinized connective tissue and a few blood vessels. There were also a few deeply stained oval and round nuclei, some of which were identified as lymphocytes; others had the appearance of fibroblasts.

A follow-up examination made nine months after the operation showed complete disappearance of the hypalgnesia over the left cheek and slight residual pallor of the left optic disc,



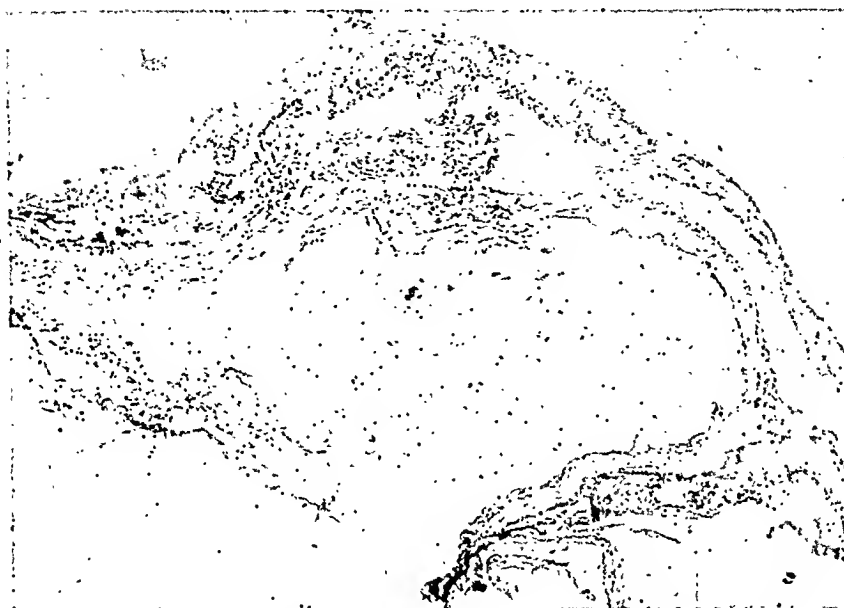


FIG. 4. Specimen of cyst wall showing dense hyalinized connective tissue, few blood vessels and deeply-staining round and oval nuclei.

with vision in the left eye still 15/20. The patient stated that she has not felt so well in five years.

#### COMMENT

Pia-arachnoidal cysts of the posterior fossa as found in adults must be distinctly differentiated from arachnoidal cysts in the posterior fossa which occur in infancy or during early childhood. The latter are the result of a compensatory mechanism secondary to congenital defects in the posterior fossa. Such congenital defects have been reported by Scarff,<sup>3</sup> Sahs,<sup>4</sup> Cohen,<sup>5</sup> Taggart and Walker,<sup>2</sup> Shyrak and Alexander<sup>7</sup> and Walker,<sup>8</sup> and most often consist of agenesis of the cerebellum and vermis, atresia of the foramina of Luschka and Magendie, or a combination of both. These infants or children show enlarged heads, mental retardation and mental defects. Typical, however, are the roentgen ray findings of the skull which show an enlargement and deepening of the posterior fossa and characteristic markings of the lateral sinus and torcula Herophili which remain in a more cephalad position (fetal position) than usual in the parietal bones.

The two cases reported in this communication are also unlike the inflammatory

cisternal arachnoiditis which simulates cerebellar neoplasm. The diagnosis, surgical treatment and end results of this type of arachnoiditis in the posterior fossa were fully reported by Horrax.<sup>9</sup> The etiology of pia-arachnoidal cysts of the posterior fossa as found in the two cases is obscure. Similar to Craig's<sup>1</sup> two cases there was no antecedent episode of trauma or infectious process. Thompson's<sup>2</sup> contention that trauma has a direct relationship to the formation of the arachnoid cyst is not well supported by his own evidence, for in his patient the onset of symptoms was two months following the injury; the injury was admittedly not to the head nor was there even momentary unconsciousness.

These arachnoidal cysts of the posterior fossa occurred in patients during the second or third decade of life and presented the clinical evidence and x-ray findings of a benign, centrally placed posterior fossa neoplasm. However, the symptoms of recurrent headaches, vomiting and instability in gait came in bouts which were separated by fairly long intervals of complete disappearance of symptoms. It was the onset and the progression of papilledema that brought them to the attention of the neurosurgeon. Although a ball-valve mech-



anism might be functioning in these pathologic cysts, neither of these patients presented any Brun's phenomena. If we are to assume with Taggart and Walker<sup>6</sup> that the foramen of Magendie is not one hole but a series of larger and smaller holes in a meshwork of fibres formed from the anterior medullary velum, it would not be very difficult to conceive of a blocking of one or several of these perforations with subsequent trapping of fluid and the formation of a midline arachnoidal cyst. With the blocking of some of the perforation, it would be physiologic for the arachnoid of the roof of the fourth ventricle to simulate an arachnoidal villus and to attempt to invaginate into the occipital venous sinus. In short, I believe these arachnoidal cysts are not congenital but developmental and the above is offered as a possible explanation for the formation of these benign midline cysts.

There was an interval of nine years between the operations in the two patients and in neither patient were the pathologic findings even suspected prior to operation.

It is the purpose of this communication to call attention to pia-arachnoidal cysts of the posterior fossa which I believe is a distinct clinical and pathologic entity and which may not be so rare as reported. It is hoped that with the accumulation of information from a larger series of similar cases the symptomatology of this patho-

logic entity may evolve into a syndrome which will be predicted prior to operation with reasonable frequency.

#### SUMMARY

Two cases of pia-arachnoidal cysts of the posterior fossa are reported in the belief that they form a clinic pathologic entity and that with the accumulation of data in a larger series of similar cases this condition will be recognized with greater frequency.

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# INTRA-ABDOMINAL HERNIA

JULIUS LEBOVITZ, M.D.

*Woodside, New York*

**P**ROTRUSION of abdominal contents not through apertures or defects in the parietes of the abdomen but through and into openings of peritoneum are considered intra-abdominal or internal hernias. These hernias occur in the abdomen and remain there. They are called primary or congenital when the protrusions take place through some congenital defects, folds or normal fossae of the peritoneum and secondary or postoperative when they are the results of defects created through surgical procedures in the peritoneum, its appendages and ligaments.

In view of the fact that some of these hernias are complicated by various degrees of intestinal obstruction when they come under clinical observation, it is of great importance to the clinician and surgeon to familiarize himself with the anatomy and also the diagnostic possibilities of such hernias. Most of these hernias are asymptomatic and are encountered only in case of surgical intervention for some unrelated condition or at postmortem examinations. Some produce symptoms of vague character, such as abdominal pain and distress, gaseous distention or even disturbances simulating a tumor which can be felt through the abdominal wall and which may lead to a wrong diagnosis. Exner and Alexander made the claim that x-ray diagnosis can be made with great probability if certain features are present on the x-ray plate, such as disturbances in the small intestinal pattern which instead of being evenly distributed in the mid-abdomen are crowded together on one side or the other as if contained in a bag, lacking the usual freedom of motion accorded by the length of the mesentery. There is also some dilatation and loss of motility associated with a varying degree of stasis.

However, in a few percentages of cases these features lead to strangulation, presenting the dramatic classical picture of an acute condition of the abdomen with the general and local symptoms. Seldom, however, is the correct diagnosis made pre-operatively. Secondary or postoperative internal hernia occur as an immediate or delayed surgical complication after surgical procedures. Defects or artificial apertures of the peritoneum may result after operations, caused by inflammation, infection, error in technic, etc. Intestinal loops may herniate through such defects resulting in strangulation and obstruction. In gastric surgical procedures, of the posterior retrocolic variety necessitating incision in the transverse mesocolon in order to accomplish gastrojejunal anastomosis, failure of proper attachment of the transverse mesocolon to the stomach, thereby closing the lesser sac, may result in a small intestinal loop herniating behind the stomach into the lesser sac causing partial or total obstruction. Quite a number of such cases have been described in the literature. In the Mayo clinic series ten such cases were reported following gastro-enterostomies. Rents in the greater omentum, as a result of operative trauma, provide a group of these hernias. Mayo, Stalker and Miller, reviewing the Mayo clinic cases from 1910 to 1939, presented thirty-nine cases of internal hernias in detail, of which twenty-one cases, or 54 per cent, were of the postoperative type.

In pelvic surgery the various types of procedures, particularly those performed on the broad ligaments, the ventrosuspension operations, especially the Baldy-Webster type, if performed with improper care and caution may result in rents of the broad ligaments. Hunt, Pemberton and

Sager published individual cases of strangulation following the Baldy-Webster type of ventrosuspension.

The primary type of internal hernia which represents the congenital group is more rare according to statistics. Treitz in his monograph advances a reason for formation of these fossae. He claims fossae are the result of failure of fusion of the peritoneum during the third stage of intestinal rotation in fetal life when certain portions of the intestines become fixed to the posterior abdominal wall by fusion of their mesenteries to the posterior parietal peritoneum. A somewhat similar theory was advanced by Moynihan and Dobson in their monograph in 1906. They claim that these fossae are the result of failure of union of the mesenteric root with peritoneum covering the posterior abdominal wall. All the fossae around the duodenum, cecum, the foramen Winslow, the perimesenteric fossae, in the pelvis and sigmoid were treated in great detail. Hansmann and Morton compiled the percentages of occurrence of the various hernias, respectively. They found that the paraduodenal type represents 53 per cent of all cases, pericecal 13 per cent, perimesenteric 8 per cent, hernias of the foramen Winslow 8 per cent, of the pelvis 7 per cent, of the sigmoid 6 per cent and miscellaneous 5 per cent. According to their observation, hernias occur more frequently in men than women.

Hasman and Morton observed that depressions fossae may occur whenever the peritoneal reflections and folds are not protected by paretics, vessels or nerves in the mesentery or by aberrant vessels, such as the middle colic artery which comes from the aorta instead of the superior mesenteric artery. Primrose reported such a case of retroperitoneal hernia due to an aberrant middle colic artery. Improper fusion of peritoneal layers may result in formation of pouches under the cecum and ascending colon. Also, some fossae may be formed by blood vessels raising the peritoneum. A good example of this is the

paraduodenal fossa of Landzert whose existence depends upon a peritoneal fold raised by the ascending branches of the left colic artery and the inferior mesenteric vein. Therefore, these fossae actually are expressions of a regional weakness and, as such, congenital in origin. However, the fossae are not the cause or do not act in any causative way in the development of a particular internal hernia. The congenital aspect cannot be denied. Intra-abdominal hernia have been found in newborn infants. To be sure an additional factor is needed, such as the increase of intra-abdominal pressure to propel abdominal contents through and into such fossae or peritoneal defects. This is absolutely essential. Such increase in intra-abdominal pressure is amply provided for in our daily routine. This gains particular significance in industrial medicine. Any type of exertion during employment will result in increased pressure and, therefore, is important in the formation of such hernias or even in strangulation. This brings up an important point in regard to compensability of such hernias. Treatment is obviously surgical. In cases of strangulation early laparotomy is lifesaving. Whenever possible the pouch or defect should be closed preventing recurrence. Simple closure of the orifice is the procedure of choice. However, sometimes the defect is so large that closure is impossible and one must be content with reduction of the strangulation.

#### CASE REPORT

Mrs. F. D., forty-nine years old, was admitted to the hospital on October 8, 1946, with complaints of vomiting and abdominal pain in the right lower quadrant of seven hours' duration. She had had the usual childhood diseases, had never been sick before and had undergone no operations. Menses started at the age of twelve, were always regular and lasted four to five days with a twenty-eight day cycle. Last menstruation had been four years ago. She had two pregnancies. There was no loss of weight. On the morning of admission the patient woke with severe abdominal pain, localized in the

right lower quadrant, and soon after vomited a number of times; no blood was present in the vomitus. Since the beginning of her illness she had not passed flatus or moved her bowels. The patient had never had such a spell before. Physical examination the same day showed a well developed, well nourished, white female. Throat, heart, and lungs showed negative results; pulse was 78 per minute and regular; blood pressure was 124/76 and the abdomen was distended, tender all over with a more pronounced tenderness over the right lower quadrant. Bimanual examination was essentially negative; rectal examination indicated tenderness on the right side. Temperature, 100°F., white blood cells, 10,000; polymorphonuclears, 74 per cent; red blood cells, 4,510,000; hemoglobin, 88 per cent and urine, negative.

A tentative diagnosis of intestinal obstruction was made; exploratory laparotomy was decided upon. Under spinal anesthesia a mid-line incision was made under the umbilicus. Upon opening the peritoneum some ileal loops were found to be markedly distended while other loops were collapsed. Tracing down the distended loops, a pouch was found behind the cecum leading upward to the ascending colon. This pouch contained about 12 inches of ileal gut, was reddish brown in color with some hemorrhages in the wall of the gut. Most of the serosa was still shiny while others were flat. The appendix was also present in this pouch in a retrocecal position and was markedly injected. The ileal loop was delivered, covered with hot pads until the color improved and redeposited into the abdomen. The appendix was removed the pouch was closed with chromic suture and the abdomen was closed in

layers. Postoperative recovery was uneventful. The patient was able to dangle her feet the first day postoperative and she was out of bed the second day. The sutures were removed on the sixth day and she was discharged on the seventh postoperative day.

#### SUMMARY AND CONCLUSIONS

1. Intra-abdominal hernia is described.
2. Postoperative and congenital types of hernias and their origin and mechanism are discussed.
3. A case of subcecal hernia is reported.

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# PATHOLOGIC CHANGES OF THE APPENDICES EPIPLOICAE

WILLIAM B. MARBURY, M.D. AND RICHARD L. JACKSON, M.D.  
*Washington, D. C.*

EPIPLOIC appendix disease holds a lowly place in surgical consciousness and also in medical literature, largely because of the comparative rarity of the condition. This situation is unfortunate and deserves correction because, as Kno-flagh<sup>4</sup> has pointed out, infarction or torsion of the epiploic appendix are serious conditions which have been fatal in an uncomfortable number of the few cases which have come under observation. Since every case that is reported serves the dual purpose of increasing our surgical consciousness of the condition and of helping to establish some basis for preoperative diagnosis which is now so difficult, we are reporting a case of gangrenous epiploic appendix of the sigmoid colon.

Babcock has been credited with one pre-operative diagnosis. Ordinarily, however, the diagnosis is appendicitis, cholecystitis, twisted pedicle, diverticulitis, Meckel's diverticulum or intestinal obstruction from some other cause. There is a resemblance between the picture of epiploic appendix disease and that of torsion of the omentum. The sudden torsion of an epiploic appendix produces acute abdominal symptoms. The abdominal pain is not necessarily limited to the site of the torsion. In a report of seven cases of torsion of the appendices epiploicae the abdominal pain was sharp and colic-like; the amount of abdominal tenderness found was disproportionately greater than the amount of rigidity noted in relation to the duration of symptoms; hyperesthesia of the skin was pronounced.<sup>8</sup> Obesity appears to be a contributing factor since the condition is most frequently found in the obese.

D. C. Patterson,<sup>7</sup> in 1937, reported a case of a diverticulum of the sigmoid colon within an epiploic appendix. A relationship may exist between the formation of

a diverticulum and development of a pathologic condition of an epiploic appendix because a diverticulum is thought to be the result of increased pressure at a weak point in the bowel wall and a point of weakness may very well be the site at which the vessels leave the wall of the colon to enter the epiploic appendix.

Appendix epiploica is defined in Christopher's Textbook of Surgery as "a localized, pedunculated overgrowth of subserous fat directly continuous with the fat in the mesentery." Reduplication of the peritoneum enmeshing a variable amount of fatty tissue between its layers forms each appendix epiploica. These small processes or pouches vary considerably in size and shape. The largest appendages are found in the sigmoid colon although they may be found all along the large intestines with the exception of the rectum. A normal adult has about one hundred of these appendages. Their presence has been demonstrated at the fifth month of fetal life; however, a pathologic condition seldom, if ever, occurs in childhood.<sup>11</sup> Many cases have been found in the twenty to forty age group.

The function of the appendices epiploicae is undetermined. Some observers believe that they are concerned with the absorption of fluid from the large intestine. Others regard these appendages as fat pockets which act as buffers for the protection of the redundant intestinal vessels when the intestinal wall is collapsed.<sup>8</sup> This latter theory is supported by the fact that persons who have had recent, appreciable losses of weight display appendices epiploicae which are as large as those found in the obese. Apparently the fat loss from these appendages is delayed until last.

Pathologically, the appendices epiploicae may undergo calcification, intrahernial

incarceration, intrahernial torsion, intra-abdominal torsion or they may form adhesions with resultant obstruction. The two most common acute pathologic conditions of the epiploic appendix are sudden torsion or twisting of the pedicle with acute inflammation or infarction. Since each appendage is supplied with one central artery and an accompanying vein, one could reasonably expect that this poor blood supply, in combination with the long pedicle sometimes present, would predispose the part to torsion and subsequent gangrene.

Slow torsion of the appendage produces a chronic condition of the part. Gradually it becomes necrotic and spontaneous amputation follows thus producing a free abdominal body. Moore<sup>6</sup> is of the opinion that the early surgery required for patients with torsion accounts for the paucity of patients who show free abdominal bodies.

Intestinal obstruction caused by a pathologic change in the epiploic appendix has occurred in comparatively few patients. One case of intussusception of an epiploic appendix was reported in 1943.<sup>3</sup> The probable mechanism by which such a condition developed is interesting; dragging action of the fecal stream upon growth of the appendage was thought to increase gradually the length and to narrow the neck of the pedicle while at the same time tending to invaginate the base, thus weakening the muscle layer of the wall at the area subjacent to the base of the epiploic appendix and also invaginating the appendix. Gilchrist and David,<sup>2</sup> in 1943, reported finding lymph glands in the appendices epiploicae contained in five specimens of large bowel resected for carcinoma. Of the ten lymph nodes that were found in the appendages, six were involved in the carcinomatous process. Thus, it is apparent that malignant changes do occur, adding one more hazard to the condition.

Max and Philip Thorek<sup>10</sup> reported an epiploic appendix patient who developed an abscess formation two months after an operation for hernia. Postoperative epi-

plitis may be either chronic or acute and of thrombotic or embolic origin. G. H. Colt<sup>10</sup> reported three cases of appendices epiploicae and stated that Johanssen, in 1927, collected reports on twenty cases. Randall,<sup>11</sup> in 1932 reported one case, which was more or less thrombotic or embolic in origin since there was no torsion of the appendage. Porter,<sup>9</sup> in 1943, could find only sixty cases of torsion or acute inflammation of the appendices epiploicae in the medical literature.

#### CASE REPORT

The patient, a short, heavy-set man forty-one years old, complained of abdominal pain which had begun at 5 A.M. the previous morning. The pain was generalized and there was no nausea or vomiting. His temperature was normal throughout the day. When he was seen the following morning he stated he had slept fairly well but that he had been "conscious of his abdomen." This discomfort persisted. His temperature was not 99°F., the leukocyte count 13,000 and the urine negative.

His past history was uneventful except for an attack of abdominal pain and diarrhea four years ago. His temperature at that time had been 102°F. and the leukocyte count 18,000. A diagnosis of colitis had been made.

Physical examination showed the abdomen to be distended with marked tenderness over McBurney's point and in the hypogastric region. A diagnosis of appendicitis was made and the patient was sent to Emergency Hospital for surgery.

Using avertin and ethylene gas anesthesia, a McBurney incision was made. The vermiform appendix was difficult to locate and in the course of exploration a small mass was felt in the pelvis just beyond an area the patient had indicated was painful. However, it was thought that the possibility of an acute appendix had to be excluded and consequently the McBurney incision was extended in both directions even though the muscle had to be cut. A retrocolic appendix was found just below the liver.<sup>5</sup> In order to expose the appendix for its entire length the ascending colon was reflected mesially. The appendix was then freed and removed with considerable difficulty, in the routine manner and the stump turned in. Following this attention was again focused on the

pelvic mass low in the midline which, when brought out, was found to be a gangrenous epiploic appendix about the size of a walnut attached to the sigmoid colon. It was plastered to the bowel and had to be freed before it could be removed. After amputation the stump was inverted with a continuous Dulox suture. The wound was then closed in layers without drainage and particular care was taken to bring the divided muscles together with interrupted mattress sutures. The patient's condition was satisfactory when he was taken from the operating room.

The postoperative course was decidedly stormy. Wangenstein drainage was started the day of operation and continued for twelve days because of persistent distention. Intravenous infusions were given three times daily and insulin, units X, were given with each infusion because of the high blood sugar level produced by the glucose solution. Vitamin B complex, ampule one, was given once daily. Auscultation of the abdomen showed some occasional peristalsis but it was not sufficient to carry off the gas. Pitressin and enemas, milk and molasses and 1-2-3 resulted in the passage of fairly satisfactory stools and the expulsion of some gas. Turpentine stupes were applied almost continuously. On the fifth day the patient developed hiccoughs which were very annoying. On the eighth postoperative day he was given a transfusion of whole blood and on the following day he received 500 cc. of blood plasma. His temperature ranged from 101 to 103°F. for about two weeks. The wound was watched carefully for signs of infection but none appeared until the tenth day and then only to a slight degree. The patient had an auricular paroxysmal tachycardia and some dilatation of the right heart. At no time were cyanosis or dyspnea noted. This condition was watched by a medical consultant. On the twentieth postoperative day a flat plate of the abdomen showed marked dilatation of the loops of both the large and the small bowel with gas. There were no definite fluid levels. The appearance was that of an ileus rather than of an obstruction. Examination of the sigmoid and descending colon with a barium enema showed no abnormality.

At this point, however, the patient began to improve. His temperature returned to normal and he was able to retain a soft diet. He had normal bowel movements and the abdomen

remained soft. On the thirty-first postoperative day the patient was discharged.

This case demonstrates the necessity for careful abdominal exploration when the anticipated condition does not appear to be entirely responsible for the severity of the clinical symptoms. Epiploic appendix disease merits consideration not only in these cases but also in cases of acute abdominal conditions of undetermined cause, particularly when at operation no other pathologic lesion can be located readily.

#### SUMMARY

1. The literature on epiploic appendix disease is reviewed briefly.

2. Epiploic appendix disease presenting acute symptoms is a definite pathologic entity and, as such, deserves an appropriate place in surgical consciousness.

3. One case of a gangrenous epiploic appendix of the sigmoid colon, diagnosed preoperatively as appendicitis, is presented.

The value of careful exploration during operation, particularly when the preoperative diagnosis appears questionable, is demonstrated.

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# ENTEROGENOUS CYST IN AN ABERRANT VITELLINE DUCT

FRANK P. SAINBURG, M.D.

*New York, New York*

ONE of the most infrequently encountered, and even less frequently diagnosed, embryologic anomalies is enterogenous cyst. Although a number have been discovered incidentally, it is only when a complicating factor such as intestinal obstruction, hemorrhage or infection supervenes that this abnormal cyst brings the patient to the operating room. Thus, in a recent comprehensive review of the literature and with the addition of their own case, Custer, Kellner and Escue<sup>1</sup> found that most of the patients with enterogenous cyst have been operated upon because of obstructive phenomena.

I am presenting herewith a case which appears to be unique in that a similar anomaly with its ultimate fate has not been described in recent medical literature.

## CASE REPORT

J. T., a sixteen year old boy, entered Bellevue Hospital on October 1, 1945, complaining of abdominal pain of thirty-six hours' duration. This began as generalized abdominal pain, but in the twelve hours prior to admission had localized in the right lower quadrant. He had been nauseated and vomited several times on the day of admission. Bowel movements were normal and there was no melena. There was no history of umbilical discharge.

His past history revealed that six years previous to admission this patient had an appendectomy through a McBurney incision. The operative report states that no exploration of the peritoneal cavity was performed and no abnormalities were noted except for an acute appendicitis. The patient made an uneventful recovery. Otherwise the past history was not remarkable.

Physical examination revealed the following: temperature, 102°F., pulse, 110 and respirations, 24. The patient was a well developed and nourished, intelligent boy who appeared acutely ill and dehydrated. Positive physical findings were limited to the abdomen in which

there was generalized muscle spasm and tenderness, exquisite in the right lower quadrant just beneath a well healed McBurney scar. An ill defined mass could be palpated in this region. The umbilicus appeared normal with no evidence of herniation or discharge. Rectal examination revealed marked tenderness in the right vault.

The laboratory data disclosed that the urine was entirely normal; hemoglobin, 15 Gm.; leukocyte count, 23,500, 94 per cent polymorphonuclear leukocytes with 24 per cent transitional forms; 6 per cent lymphocytes. The preoperative diagnosis was either Meckel's diverticulitis, or abscess about the old stump of the appendix.

Under cyclopropane anesthesia the abdomen was opened through a right rectus incision. Upon entering the peritoneal cavity some cloudy fluid was encountered. When this was aspirated, an inflammatory mass surrounded by omentum was revealed. The omentum was dissected free and the mass was found to extend from the cecum into the under surface of the umbilicus. Just beneath and incorporated in the umbilicus was a cystic mass about 3 cm. in diameter which was in direct continuity with a tubular-like structure of about the same diameter, but tapering down to a diameter of 1 cm. at which point it entered the cecum on its antimesenteric border, just distal to the ileocecal valve. This structure contained purulent exudate under pressure. The cecal wall, for about 2 cm. around the mass, was covered with an exudate which involved the wall and its blood supply in the terminal mesentery.

The entire mass from the cecal wall to and including the subumbilical cyst was resected. Careful probing revealed no connection from the tube into the cecal lumen. The cecum was mobilized into the wound and held by packings. Cigarette drains were placed into the pelvis and ileocecal region. Ten Gm. of sulfanilamide was introduced into the wound and the incision closed around the walled-off cecum.

The pathologic report revealed that grossly, the specimen is received in two portions. One is an irregular nodule apparently covered by



serosa, 3 by  $2\frac{1}{2}$  by 2 cm. The surface is dull, opaquely covered by fibrin and focally hemorrhagic. On section it is found to be a portion of intestine, the lumen filled with pus and the wall measuring 4 mm. in thickness. The mucosa is distinct and the outer layers are well recognizable. The second portion is a peritoneal pouch with numerous lobules of fat. It measures 12 cm. in length and  $\frac{5}{8}$  cm. in diameter. There is marked congestion and the serosa is covered with fibrinous exudate. Microscopically, the first portion consists apparently of a section of large bowel with the mucosa thrown into folds. The mucosal layer is greatly thickened by an almost solid infiltration of lymphoid tissue with many germinal centers covered by epithelium which is intact and well preserved. The epithelium shows many goblet cells. The muscular coats are intact but show congested vessels and small focal collections of lymphocytes. The serosa is markedly congested and edematous, is somewhat thickened and also shows slight infiltrations with polymorphonuclear cells and lymphocytes. In places there are small hemorrhages in the serosa and at others there is definite granulation tissue. The lumen is filled with pus and the mucosa is ulcerated at one point. The second portion shows delicate areolar and fatty tissue with areas of congestion, granulation tissue, polymorphonuclear and lymphocytic infiltration and many small hemorrhages around the blood vessels and fibrous septa. There is focal hyperplasia of the surface mesothelium. Section taken near the tip of the sac resembles ileum and is otherwise similar to the section described above.

*Pathologic Diagnosis:* Infected enterogenous cyst, remnant of vitelline duct.

The postoperative course consisted of continuous intravenous fluids and Wangensteen drainage of the stomach. Five Gm. of sodium sulfadiazine was given daily intravenously for the first four days, and penicillin 30,000 units intramuscularly every three hours for seven days.

His temperature,  $103^{\circ}\text{F.}$  on the first day, declined slowly to normal on the seventh day. The packings and drains were removed gradually from the fourth to the seventh postoperative days. At no time was there any fecal drainage. On the fifth postoperative day, the patient had nine foul, bloody bowel movements. He was out of bed on his tenth day but

remained in the hospital for barium studies of his intestine. The patient was discharged on his twenty-third day with the wound well healed. Barium studies, three and twelve weeks postoperatively, revealed no abnormality of the ileum or cecum. The patient was entirely well, on a full diet, with the wound well healed, and back at work when seen nine months later.

#### COMMENT

At operation the possibility that the gangrenous-appearing cecum with its embarrassed vascular supply might proceed to complete necrosis and the establishment of a fecal fistula was considered. However, because of the extensive infective process with generalized peritoneal reaction, it was thought inadvisable to resect the involved bowel, and the extent of cecal involvement precluded inversion. Accordingly, it was expected that by holding the cecum into the wound and surrounding it with packings, if a cecal fistula resulted it could be dealt with electively. The several foul, suppurative, bloody bowel movements on the fifth postoperative day are the probable explanation for the lack of fecal drainage from the wound, subsequent rapid healing and negative postoperative x-rays of the cecum. It is the author's opinion that the extensive suppurative necrotic area involving the proximal termination of the vitelline mass and the anteromedial aspect of the cecum sloughed into the lumen of the bowel and was expelled per rectum on the fifth postoperative day. Rectal examination at this time and subsequently was negative.

Although it is of unusual occurrence for an enterogenous cyst to proceed to abscess formation, I believe the outstanding feature in this case to be the occurrence of a cecal vitelline duct and the formation of an infected enterogenous cyst within it. That the structure was a remnant of the vitelline (omphalomesenteric) duct appears to be evident from the incorporation into the umbilicus distally and the wall of the intestine proximally. Microscopic sections proved the umbilical end to be of large bowel structure, but failed to show mucosa at the cecal end, which explained the fail-

ure to pass a probe through the obliterated lumen at operation.

Embryologists state that with the formation of the umbilical cord and consequent inclusion of the yolk stalk within it, the latter normally undergoes degeneration and ultimate obliteration, beginning in the sixth week of intrauterine life. However, in about 2 per cent of adults coming to autopsy, there is found some remnant of this primitive structure, varying from the not uncommon Meckel's diverticulum to the rare complete patency of the vitelline duct with an umbilical fistula. These usually originate in the terminal 30 inches of the ileum. This case appears to be unique in that the vitelline duct originated distal to the ileocecal valve. Morgan,<sup>2</sup> in a recent review of the 105 cases of persistent vitelline duct reported in medical literature plus a case of his own, found that these anomalies usually had an umbilical fistula and were therefore operated upon in infancy either electively or subsequent to intestinal prolapse and obstruction. In this case there was no evidence of a fistula ex-

ternally and the lumen of the proximal end of the duct was obliterated.

It is of interest that this condition was not observed at the time of appendectomy six years previously. This was probably because of the necessity for removing the acutely inflamed appendix without exploration, and also to the small amount of exposure through an intramuscular incision.

#### SUMMARY

An unusual case of an infected enterogenous cyst of large bowel origin occurring in an incompletely obliterated vitelline duct has been presented. This case is believed to be unique in that the vitelline duct was derived distal to the ileocecal valve. Complete recovery ensued following surgical excision.

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# LIPOMA OF THE COLON CAUSING INTESTINAL OBSTRUCTION\*

A. LESTER WEISBERG, M.D.  
*New York, New York*

OF the benign tumors of the gastrointestinal tract, lipomas are relatively infrequent while adenoma and myoma are fairly common. In the Mayo Clinic, twenty five cases of lipoma of the gastrointestinal tract were discovered in 3,924 consecutive autopsies, an incidence of 0.6 per cent. Kirschbaum, in a review of 5,724 autopsies, found an incidence of 0.2 per cent. In a survey, reported by Rosen, of gastrointestinal tumors from the Bronx Hospital between 1940 and 1946, of thirteen benign tumors of the small bowel, all found at autopsy, three were multiple lipomas. Of fifty-three benign tumors of the large bowel during that period three were lipomas, one a lipoma of the appendix found at operation for acute appendicitis, the second a lipoma of the descending colon found at autopsy and the third a lipoma of the transverse colon reported in this article.

Anatomically, lipomas may be divided into two groups: the subserous and the submucous, while a few may be both subserous and submucous. The submucous type is more common; it is more frequently found in the large bowel and is usually single. While subserosal tumors may attain large size, finding little resistance to their expansion toward the peritoneal cavity, submucous lipomas do not attain a large size because they give rise to symptoms sooner and are therefore treated earlier.

The relative infrequency of lipomas in the colon and rectum can be judged by the fact that in 1937 Pemberton and McCormack were able to collect only 116 cases in a comprehensive review. Gault and Kaplan reported an additional fourteen

cases, one of them their own, in 1941. Their most frequent location was in the cecum, ascending colon, sigmoid, transverse colon and rectum in that order. They occurred slightly more frequently in women usually between thirty and sixty years of age.

The most common clinical phenomenon is intestinal obstruction caused by the encroachment of the lipoma upon the lumen of the bowel, and may be preceded by abdominal complaints of a vague nature for weeks or years. Intussusception occurred in over 50 per cent of colon cases reported by Comfort. Pemberton and McCormack reported a 50 per cent incidence in their Mayo Clinic cases. In 25 per cent of the cases they also found slow hemorrhage into the bowel from erosion of the dome of the lipoma. Instances of spontaneously extruded lipomas are very uncommon, but they have been reported when the lipoma breaks off, usually from a small, thin pedicle. It is obvious, therefore, that the size, location and behavior of the tumor determine the nature and onset of symptoms. The average duration of symptoms reported by Pemberton and McCormack was 41.5 months.

X-rays cannot be depended upon to differentiate lipoma from carcinoma, both are usually reported as a filling defect, obstructive lesion, gaseous distention of a portion of the bowel, etc. Diagnosis of lipoma of the gastrointestinal tract is rarely if ever made except at laparotomy, necropsy, if it is spontaneously extruded, or if the tumor during intussusception presents itself at the anus. The most important consideration in the surgical treat-

\* From the Surgical Service of Dr. J. A. Landy, The Bronx Hospital, N. Y., N. Y.

ment of a submucous lipoma of the colon is the extent of bowel wall involvement. In most reported cases either resection in one or more stages or a Mickulicz exteriorization or modification thereof was carried out. Browne and McHardy state when upon exploration there are indications that the tumor is benign that "this is inconclusive since the most common benign tumor of the colon is the potentially adenomatous polyp; it is therefore apparent that simple polypectomy will seldom be depended upon, the procedure usually decided upon being a local resection of the tumor bearing segment of colon and a primary anastomosis." However, Comfort in 1931 advocated the adoption of excision and less radical surgery if the lipoma was recognized before or at operation. If there is no bowel wall involvement and the tumor is soft, smooth and freely movable within the lumen of the bowel, we believe that colotomy and simple excision of the tumor is sufficient. This, with subsequent replacement of the incised area of bowel after healing of the colotomy wound, is the less risky procedure. Colotomy with immediate replacement into the abdomen may conceivably be done, but it carries with it the additional hazard of peritonitis from leakage. In general it must be emphasized that whenever any kind of tumor of the bowel is discovered, no matter how benign, especially if it projects into the lumen of the intestine, it should be removed since it always carries with it the threat of obstruction either by occlusion of the lumen or by intussusception.

#### CASE REPORT

R. K., No. 167877, an acutely ill female, forty-nine years of age, was admitted to the medical service of the Bronx Hospital on June 27, 1945, with the diagnosis of subacute intestinal obstruction. She gave a history of progressive constipation and increasing severity of abdominal pains of several months' duration; the pains had been worse in the past few weeks, with no bowel movement or passage of flatus for forty-eight hours previous to admission. She had vomited two or three times daily for

the past few days. She had had a similar episode about two weeks ago and had lost 5 pounds in the past four weeks. The previous history was irrelevant. The day after admission a flat plate of the abdomen revealed gaseous distention from the cecum to the mid-transverse colon. On June 29th, two days after admission, she was transferred to the surgical service for operation. She was operated upon the same day.

The abdomen was opened through a right rectus incision; it was our intention to do a preliminary decompressing cecostomy prior to further radical surgery. Exploration revealed a tumor of the mid-transverse colon, globular, about the size of an orange, smooth, soft and freely movable within the lumen of the bowel, without any apparent extension along the bowel wall. There was no evidence of metastases to the liver or omentum. Because we suspected that the tumor might be benign and there was no bowel wall involvement, we decided upon the following course of action: The tumor was first exteriorized over a glass rod after approximating the proximal and distal limbs with chronic catgut. Three days later, through a transverse incision of the bowel proximal to the mass, the tumor was everted and removed by excision across a broad base of mucosa which completely surrounded it. The incision in the transverse colon was immediately closed by a layer of Connell inversion sutures covered by two layers of interrupted Lemberts; it was left exteriorized on the abdominal wall in case of leakage. The incision healed completely with only slight leakage for two or three days so that we were able to replace the bowel on July 27th. This was accomplished by freeing the bowel from the abdominal wall and approximating the fascia over it so that we avoided the danger of opening the peritoneal cavity and replacing exposed, exteriorized bowel into it. The patient was discharged in good condition twelve days after the last stage.

Pathologic report revealed the following: Grossly, an adipose mass 8 by 6 by 2 cm enveloped by a capsule of mucosa was found. Microscopically, it consisted of adult adipose tissue. The supporting connective tissue was well hyalinized and well vascularized.

Diagnosis: Submucous lipoma of the colon.

On March 29, 1946, the patient was re-examined. The wound was well healed and

there was no evidence of herniation. She still complained of constipation. A barium enema taken that day revealed no organic lesion of the colon. The colon appeared atonic and elongated.

#### SUMMARY AND CONCLUSIONS

1. Of the benign tumors of the gastrointestinal tract lipomas are relatively infrequent while adenoma and myoma are fairly common.

2. Anatomically they fall into two groups: the submucous and subserous, the former being more common and more frequently found in the large bowel.

3. The most common clinical phenomenon is intestinal obstruction caused either by encroachment of the lumen of the bowel by the tumor or by intussusception.

4. X-rays cannot be depended upon to differentiate lipoma from carcinoma.

5. If there is no involvement of the bowel wall, excision and less radical surgery should be done.

6. Whenever any tumor of the bowel is discovered, no matter how benign, especially if it projects into the lumen of the bowel, it should be removed since it always carries with it the threat of obstruction by occlusion of the lumen or by intussusception.

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# New Instrument

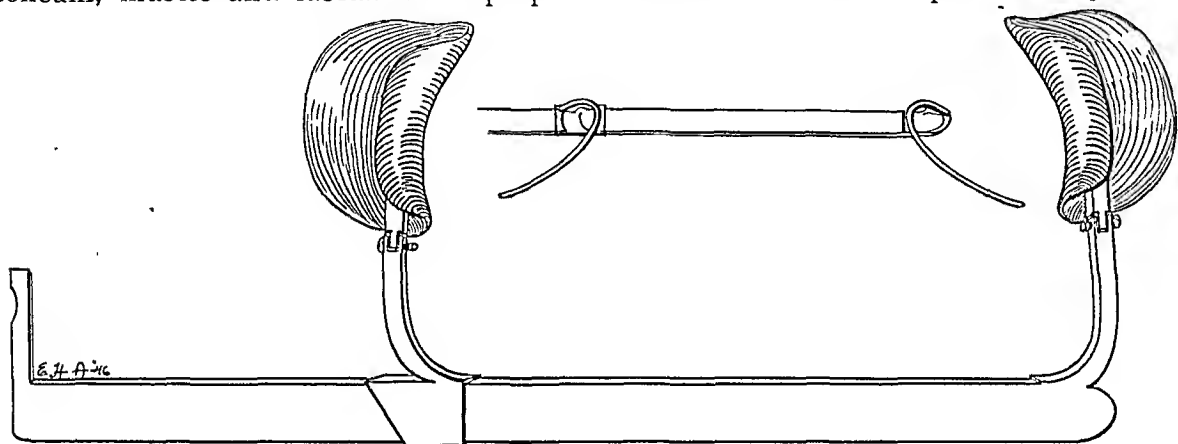
## SELF-RETAINING RETRACTOR FOR THE SUPERFICIAL LAYERS OF THE ABDOMINAL WALL\*

EUGENE A. GASTON, M.D.

*Framingham, Massachusetts*

**A**CCURATE reapproximation of the layers of the abdominal wall demands adequate exposure of peritoneum, muscle and fascia. With proper

relaxation of the abdominal muscles, the clamped edges of the peritoneum and its superjacent fascia can usually be readily elevated to make exposure easy. The



0 inches 1 2 3 4 5 6 7 8 9 10 11

FIG. 1. Sketch of retractor; note angle at which blades are set to assure exposure at extremities of wound.

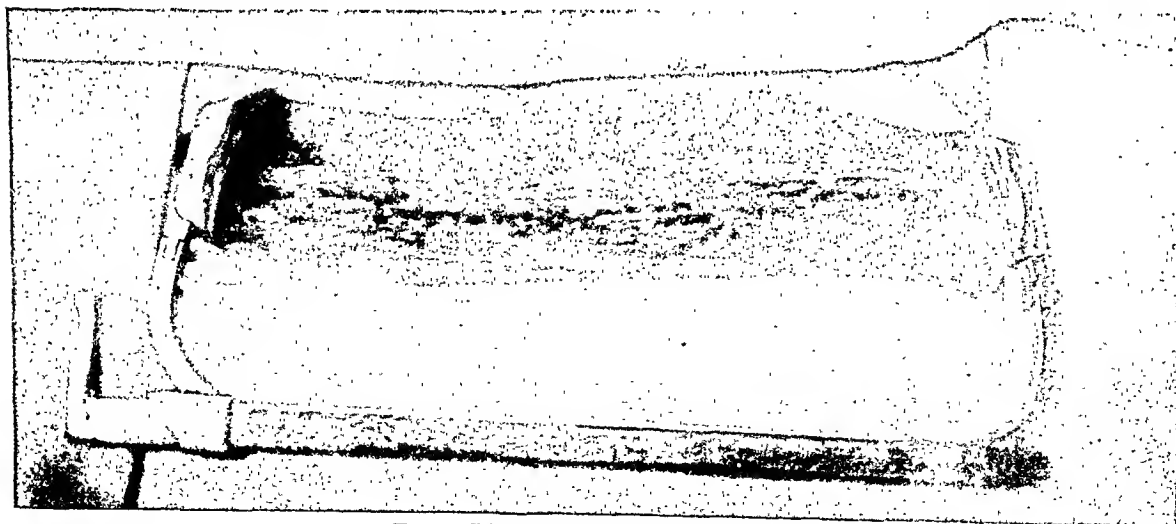


FIG. 2. Photograph of retractor in use.

\* From the Surgical Service of the Framingham Union Hospital, Framingham, Mass.

muscular and fascial layers, however, do not tolerate clamping and traction so that the overlying fat must be retracted, particularly at the extremities of the wound.

A self-retaining retractor designed to retract skin and fat away from fascia has obvious advantages, particularly in smaller hospitals in which the number of surgical assistants is limited. To this end the instrument has been gradually evolved through numerous modifications. (Figs. 1 and 2.)\* The following features have been found

\* Available through the Thomas W. Reed Co., Boston, Mass.

important in securing the desired results: (1) The length is sufficient for any wound likely to be made in the abdominal wall. (2) The obliquely cut sleeve of the movable arm prevents slipping after adjustment in the wound has been made. (3) Hinging of the relatively short blade arms permits the long bar to rest on the abdominal wall, assuring stability in both vertical and transverse wounds. (4) The blades are set at sufficient angle to give exposure at the extremities of the wound and are wide enough to roll the fat away from the fascia in the central portions.



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# The American Journal of Surgery

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A PRACTICAL JOURNAL BUILT ON MERIT

Fifty-seventh Year of Publication

VOL. LXXVI

AUGUST, 1948

NUMBER TWO

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## Editorial

### THE "SILENT" GALLSTONE

IN cases in which gallstones are associated with symptoms of reasonable severity, doctors on the whole have no hesitation in strongly advocating that operation be undertaken for their removal since this is the only way to achieve that object. On the other hand, when these stones are so silent as to scarcely obtrude their presence upon the feelings of their host a very different attitude has been, and still is, widely adopted. This is one of *laissez faire*, exemplified by the patient who triumphantly tells of the advice once given her in some such terms as "My doctor told me that so long as my gallstones don't trouble me I shouldn't trouble them." Since such advice can only have its inception in a lack of knowledge or appreciation of the grave potentialities of stones in the biliary tract, it was believed that a brief discussion of the subject, prompted as it is by certain recent experiences of the writer, would not be inopportune.

While everyone does, or at least should, know that neglect of biliary tract disease often leads to complications of a serious and sometimes fatal nature, we believe that what is not so well known is the corollary, obviously of the greatest importance, that in biliary tract disease, complications arise almost entirely in cases in which gallstones are present and practically never in those in which they are absent. There are

two reasons for this: The first lies in the marked propensity which gallstones have for causing obstruction, partial or complete, of some portion of the biliary tract, the result of their presence in a hollow muscular system of variable caliber in which they are able to move about. Secondly, inflammation, acute or chronic, of at least part of the tract is a frequent accompaniment of gallstones. Hence the complications which may, and frequently do, arise in such cases may be due to (1) obstruction, (2) inflammation or (3) to a combination of both these factors, this combination having more baneful effects than either of its component elements acting alone. Thus, within the orbit of complications are to be found multitudinous conditions which include cholecystitis, acute and chronic, hydrops and empyema of the gallbladder, pancreatitis, acute and chronic, obstructive jaundice, cholangitis, acute and chronic, internal biliary fistula, etc. Some constitute an acute threat to the life of the afflicted individual, others act in a no less certain but more chronic and insidious manner by damaging liver function. In the former type the acute nature of the symptoms usually assures that medical advice will be quickly sought, and it is found that this type, although serious enough, fortunately often occurs sufficiently early in the progress of the disease



of the biliary tract to enable early diagnosis and proper surgical treatment to result in a large percentage of cures. The tragedy of the latter type lies in the fact that mildness or absence of symptoms may for some time engender a false sense of security, obscuring the necessity for surgery which alone can hold any hope of cure and so by the time symptoms have become severe enough to force the issue, it may already be too late to combat the pathologic changes which have occurred consequent upon the unchecked progress of the disease. An example of this type of case was a middle-aged woman who had had symptoms suggestive of biliary tract disease for some years but did not seek medical advice until impelled to do so by the symptoms' increased severity during the previous two months. At operation there was found a small pericholecystic abscess containing thick, foul-smelling pus and a single faceted gallstone; thick, vascular adhesions and the poor condition of the patient precluded further exploration. Autopsy revealed a cholecystoduodenal fistula, several gallstones, suppurative cholangitis and multiple liver abscesses. Such a case as this shows us only too clearly the penalty which may have to be paid by the possessor of gallstones if they are allowed to remain until they can indulge their habit of initiating progressive pathologic changes in the biliary tract. Since it is not possible to know just when they may begin to do so, it is obvious that the sooner their removal is undertaken the better the chance of preventing the occurrence of complications.

No discussion of the complications associated with gallstones would be complete without mention of carcinoma of the gallbladder. In the first place, it is recognized that, except in rare instances, this condition occurs only in gallbladders in which stones are present and more particularly when these are of the larger variety and few in number—the very type so often associated with few or no symptoms. This fact is of importance as it leaves us no choice but to admit that the presence of

stones in a gallbladder can act as a factor predisposing this viscus to the development of carcinoma. This being so, while it is fortunate that this disease is relatively uncommon, there is still no way of knowing in which cases it will or will not occur if the stone-containing gallbladder is allowed to remain *in situ* and, in addition, it should always be borne in mind that carcinoma is no respecter of persons. Further, it cannot be too strongly emphasized that nearly every case of carcinoma of the gallbladder when explored surgically proves to be hopelessly inoperable so that for all practical purposes it can be said to be a uniformly fatal disease. It follows from this observation that the only treatment which holds any hope is essentially one of prophylaxis and consists of removal of the stone-containing gallbladder before it has become carcinomatous. Yet in one of the writer's recent cases the medical advice given to the patient when gallstones, three in number and of large size, were first demonstrated by roentgenography three years previously was that there would be time enough to deal with them if and when they began to cause troublesome symptoms. Although these had been present only between two and three months when operation was performed, and even then could not be described as severe, carcinoma of the gallbladder was found with widespread peritoneal carcinomatosis and a liver already the seat of metastasis. One can reasonably assume that carcinoma was not present at the time the gallstones were discovered so that in this case the sense of security resulting from the absence of symptoms, added to a disregard of the warning their presence alone should have conveyed, led to neglect in taking timely advantage of the opportunity that presented itself for surgical treatment which alone could have saved the patient from this fatal complication.

What can be done to prevent the occurrence of such tragedies? We shall always have with us the individual who shuns the search for medical advice until it is too late, or he who refuses to run the low risk of the

operation which will restore him to health; such individuals are acting within their personal rights and little, if anything, can be done to help them. However, the tragedies, the prevention of which this communication is concerned, are those which occur in patients as a result of fatal complications which have arisen because of delay in treatment that is the direct outcome of advice given by accredited members of the medical profession. We therefore wish to emphasize first, that because gallstones are an important causal factor in the spread of pathologic changes in the biliary tract they constitute a definite menace to the future health of the individual who harbours them; and secondly, that when gallstones are present, absence of symptoms is no guarantor of safety for serious complications may be in, or have actually progressed beyond, their incipient stage before symptoms of any severity manifest themselves. It is evident, therefore, that prevention of complications

means not only the removal of gallstones and the concomitant treatment of any related pathologic condition, but that the operation necessary to achieve these objects should be carried out as soon as possible after either the presence of gallstones has been demonstrated or the diagnosis of biliary tract disease has been made. The only cases which should be considered as qualifying for exception to this rule are those in which associated conditions render the operative risk too great. Until physicians are willing to recognize these facts and to impress them upon patients with gallstones who seek their advice, avoidable tragedies will continue to occur.

Let us therefore keep constantly in mind that "Gallstones are a serious possession" (an apothegm of Rutherford Morison's) and in particular not allow silent gallstones to deceive us into regarding their removal as any the less essential than that of the "noisy" variety.

JAMES H. SAINT, M.D.



# Original Articles

## TECHNIC FOR RESECTION OF THE RIGHT MIDDLE AND RIGHT LOWER LOBES OF THE LUNG

RAYMOND C. SCANNELL, M.D.

*Denver, Colorado*

THE mortality and morbidity rates for pulmonary resection are now sufficiently reduced that many diseases of the lungs presenting problems in therapy have

has seen the development of advancements in technic; but in addition, this experience has permitted the accumulation of data concerning criteria of operability and post-

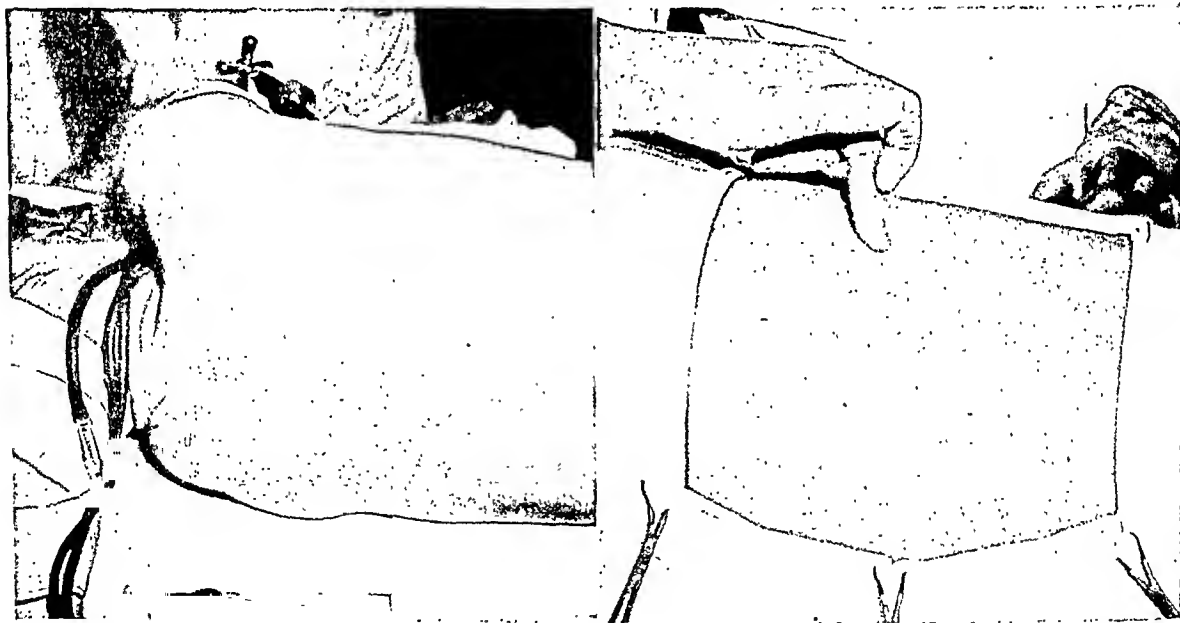


FIG. 1. Endotracheal anesthesia is in progress; a blood pressure cuff has been applied to the right arm and an intravenous needle has been placed in an antecubital vein of left arm.

FIG. 2. The field painted and draped; finger indicating the inferior angle of the scapula.

come within the range of satisfactory treatment.

Repeated performance of lobectomy has evolved a fairly standardized technic for the operation. This technic is largely concerned with the maneuvers necessary for the isolation and the secure interruption of blood and air trunks supplying the lobes resected.

Increasing experience with lobectomy

operative treatment which have contributed much to improved effectiveness in the case management of the patients subjected to lobectomy.

The primary object of this presentation is to describe the technic of resection of the right middle and lower lobes in a clear, brief manner. The surgical technic is then integrated with the other phases of case management by the inclusion of a representa-

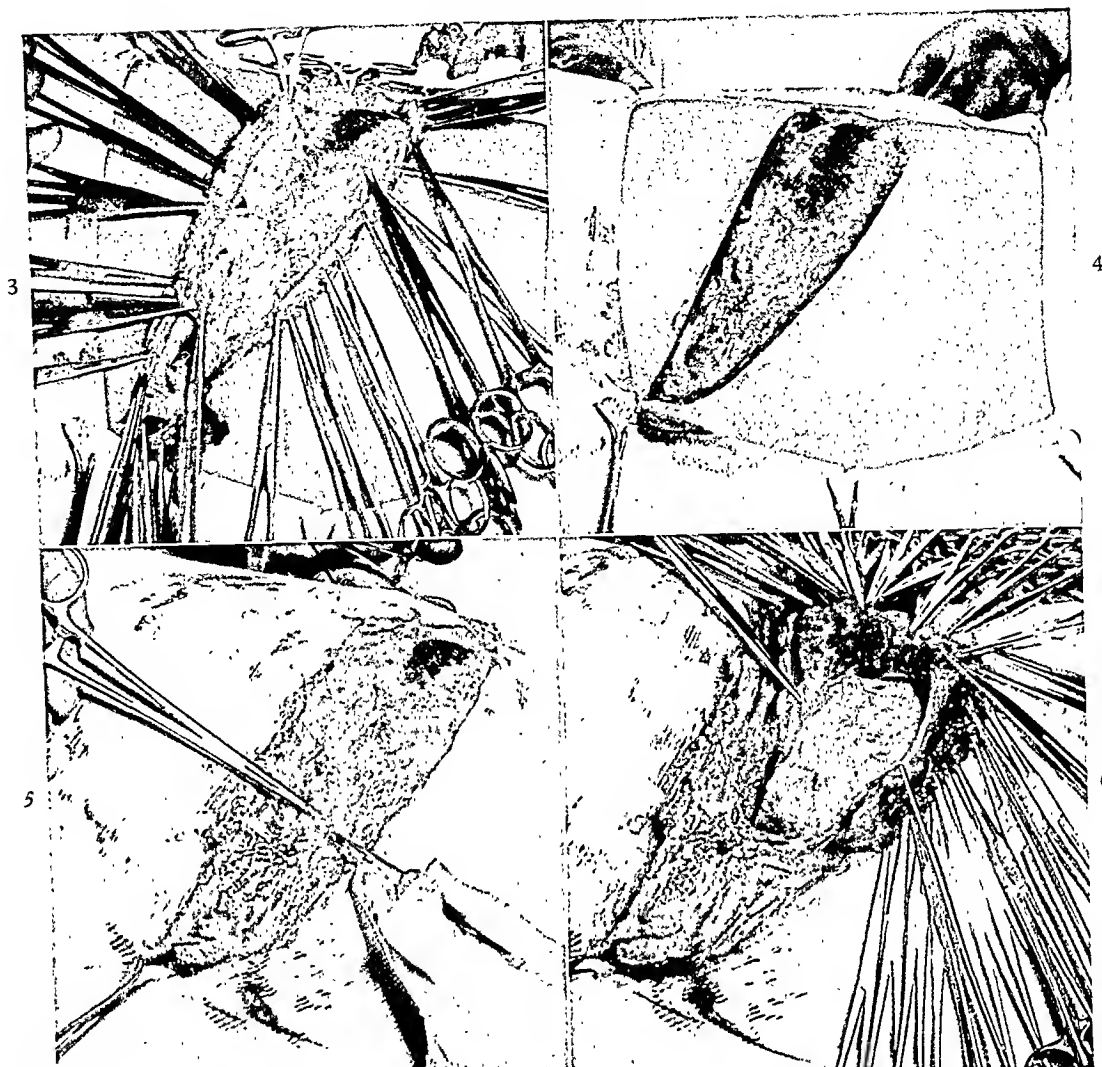


FIG. 3. Skin incision made; bleeders clamped.

FIG. 4. Skin bleeders ligated with fine cotton.

FIG. 5. Cotton stockinette applied to wound edges; fascia of the auscultatory triangle picked up and incised.

FIG. 6. The latissimus dorsi and the serratus anterior muscles cut.

tive case report from diagnosis of the disease to discharge of the patient from the hospital.

Review of 219 non-tuberculous bronchopulmonary lesions found in the diagnostic studies carried out in this endoscopic clinic immediately prior to the preparation of this presentation, and constituting a random check, showed that in ten cases the pathological condition was limited to the right middle and lower lobes alone. Right middle and lower lobe lesions occurred with varying degrees of involvement on the contralateral side in twenty other cases in the same series.

This suggests that lobectomy of the right middle and lower lobes might be considered in the treatment of approximately 14 per cent of the entire series.

Tabulation of the last one hundred lobectomies performed (segmental resection, except lingulectomy, excluded) shows lobectomy of the right middle and lower lobes was carried out in ten cases. In the same series of cases the right middle lobe alone was removed nine times and the right lower lobe was removed alone in thirteen cases. This series included cases of pulmonary tuberculosis in which one lobe or more was



FIG. 7. The muscle incision extended posteriorly with division of the exposed portions of the trapezius and rhomboid major muscles; muscle bleeders ligated with fine cotton.



FIG. 8. The right hand passed under the scapula to palpate the prominent attachment of serratus anterior on the second rib, and the first rib above it.

removed; segmental resections for tuberculomas were excluded.

tion in approximately one-third of all cases in which lobectomy will be done.

Teamwork among all concerned with the management of the case, from endoscopist to physical therapist, has demonstrably influenced the results obtained in lobectomy. The anesthetist may merit special mention, for the operation should rarely if ever be attempted without the services of an anesthetist who is geared by training, equipment and temperament to the exigencies of the operation.

#### TECHNIC

**Incision.** The skin incision for lobectomy of the right middle and lower lobes is made in a manner which will permit partial mobilization of the scapula and exposure of the sixth rib. With anesthesia induced and respiration controlled by tracheal intubation, the patient is positioned on the left side. (Fig. 1.) In this position the inferior angle of the scapula overlies the sixth rib. (Fig. 2.)

The skin incision extends obliquely an-

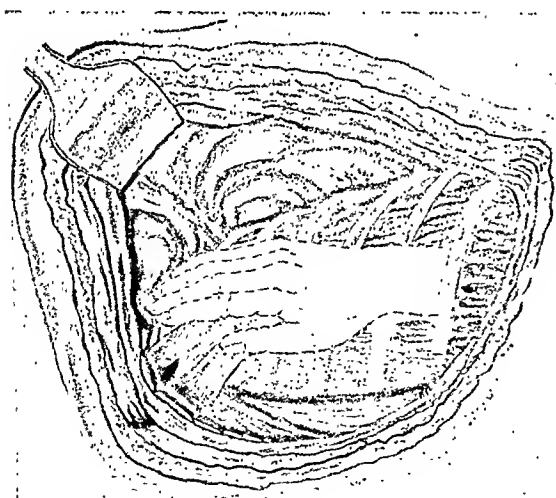


FIG. 9. Diagram showing the serratus anterior attachment to the second rib. The first and second ribs are usually identifiable by palpation.

The totals suggest that the technic of excision of the right middle or the right lower lobe, or both, will have direct applica-

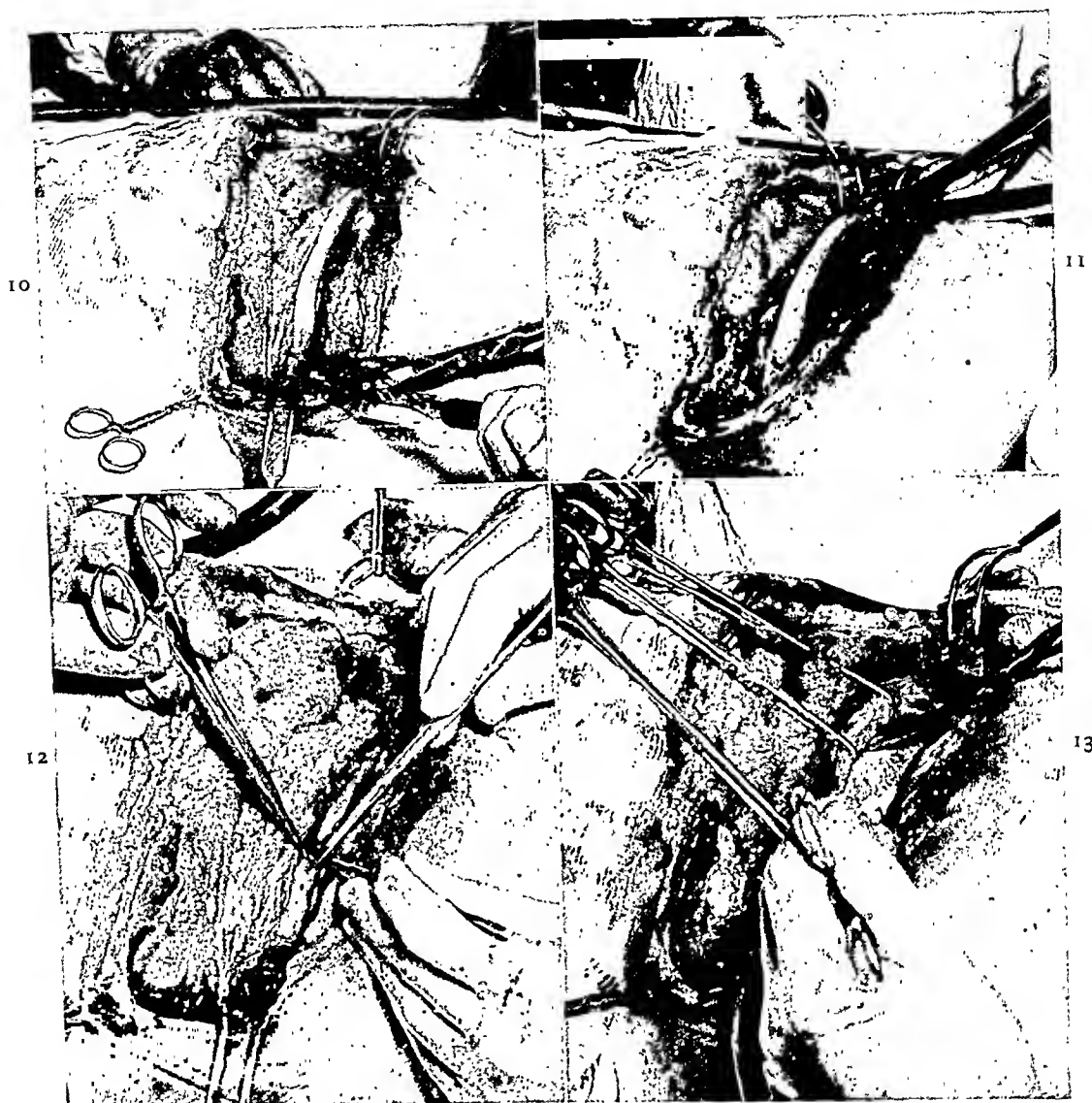


FIG. 10. The sixth rib exposed by subperiosteal elevation and divided posteriorly 2 or 3 cm. from the angle.

FIG. 11. The Bethune rib shears divide the sixth rib anteriorly.

FIG. 12. The periosteum and parietal pleura in the bed of the sixth rib picked up and incised.

FIG. 13. Incision in the pleura completed for the length of the resected portion of the sixth rib; adhesions between the lung and chest wall divided, using a "dissector" at this stage.

teriorly and downward over the course of the sixth rib from a point 5 cm. from the dorsal vertebral spine to the posterior axillary line, passing inferior to the angle of the scapula.

The incision first includes the full thickness of the skin and the subcutaneous fat to the muscle layer. Bleeders are clamped and tied with fine cotton, No. 50 black. (Figs. 3 and 4.) Skin drapes of stockinette are secured to the skin edges by towel clips applied from the underside of the drapes.

The wound, which is thus completely protected from the skin, is now deepened to the thoracic cage. Incision is made through the auscultatory triangle formed by the converging margins of the major rhomboid, the trapezius and the latissimus dorsi muscles. (Fig. 5.) The finger introduced through the opening palpates the ribs and intercostal structures.

The muscle layer is cut over the finger which advances in the easily separated line of cleavage anteriorly (Fig. 6) and then



FIG. 14. Right stem bronchus exposed above the level of the middle lobe bronchus.

posteriorly and superiorly. (Fig. 7.) Bleeders are caught as they are cut and tied with fine cotton.

Alexander refers to the method of Carter in making the incision in the muscles with reduced blood loss. As the incision is made

the muscle on either side is compressed between the finger and thumb of the operator on one side and of an assistant on the other. A momentary release of the compression shows the location of the bleeders and they are at once clamped.

*Pleura Opened.* The hand sweeps upward and forward beneath the scapula. (Fig. 8.) The attachment of the serratus anterior to the second rib is prominent and provides an easily palpable landmark. (Fig. 9.)

With a scalpel an incision along the center of the sixth rib divides the periosteum over the outer surface of the rib. A Matson or similar type raspatory strips the periosteum free, and a sufficient length of rib is removed with a rib shears to provide exposure when the pleura is opened. A section of rib from the transverse process to the posterior axillary line will usually allow such exposure (Figs. 10 and 11), but further lengths of rib or protruding stumps may be cleared of periosteum with a Sanderson periosteal elevator and cut with a Sauerbruch double action rongeur. About 18 cm. of rib is removed.

The pleura is opened by an incision

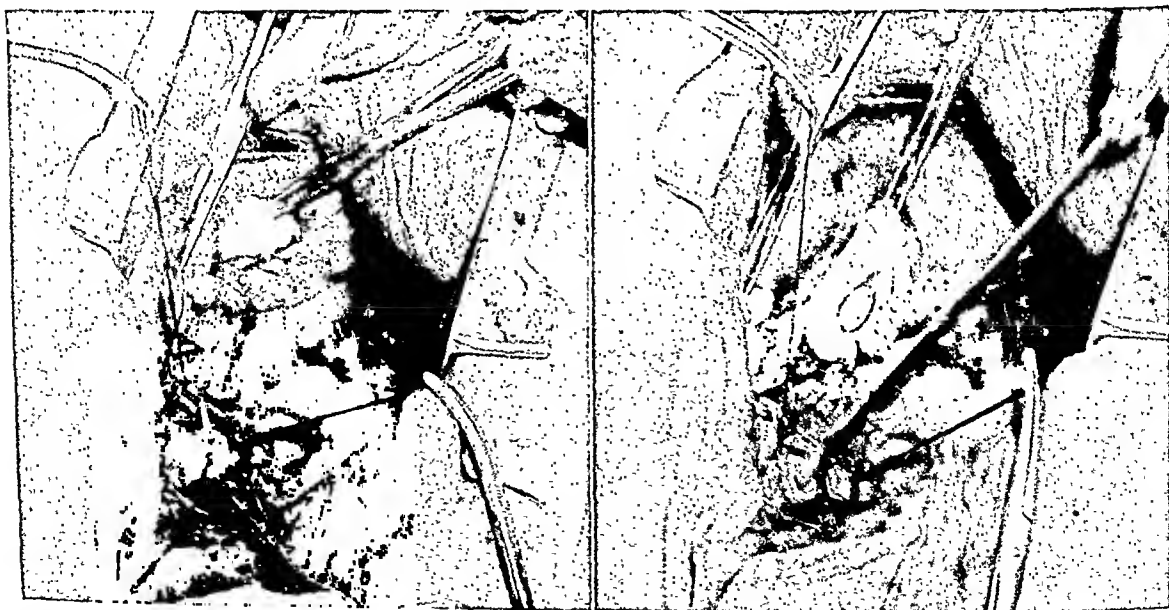


FIG. 15. Right stem bronchus tied off below; stay sutures inserted above the contemplated level for cutting.  
FIG. 16. The bronchus cut and an aspirating unit removes secretion from the proximal stump of the bronchus.



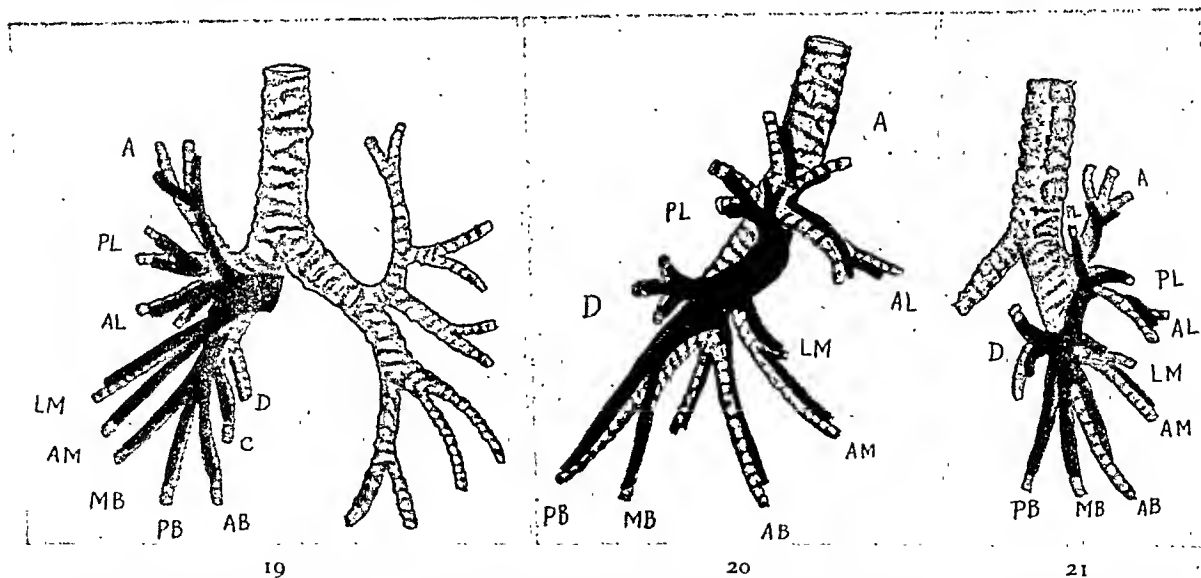


17

18

FIG. 17. The bronchial stump ready for suturing.

FIG. 18. The bronchus closed by a row of interrupted fine No. 00 chromic catgut on atraumatic needle.



19

20

21

FIG. 19. Diagrammatic anteroposterior view to show relationship of pulmonary artery to right bronchial tree. The letters indicate the division bronchi of each lobe with the nomenclature used by Foster-Clark. In the right upper lobe "A" indicates apical division; "PL," posterolateral division; "AL," anterolateral division. The relationships shown are based on the studies of Boyden.

FIG. 20. Diagrammatic lateral view. "AM" indicates anterior middle division; "LM," lateral middle division.

FIG. 21. Diagrammatic oblique view from the right and posterior. In the right lower lobe "AB" indicates anterior basic division; "MB," middle basic division; "PB," posterior basic division; "D," the dorsal division of the apical segment of the right lower lobe.





FIG. 22. Pulmonary artery exposed and ligated.

through the periosteal bed of the rib with care to avoid injury to the intercostal structures and to avoid perforation of the lung through an underlying adhesion. (Fig. 12.) The anesthetist is warned as the pleura is about to be opened, so that the respirations of the patient will continue smoothly under control by the anesthetist if necessary.

**Pneumonolysis.** A complete pneumonolysis, including development of the fissures, is now performed if necessary. (Fig. 13.) This is done by blunt and sharp dissection, and useful instruments in effecting this stage of the procedure are: stick sponges, "dissectors," a long handled scissors of the Reinhoff type and a transluminating lamp. After the pneumonolysis has been carried out for a distance of several inches about the incision in the pleura, the rib spreading retractors are inserted to provide further exposure. The large, heavy, Finochietto rib retractor gives satisfactory exposure; where a smaller type of rib retractor is used, two may be necessary, one in the anterior and one in the posterior angles of the wound.

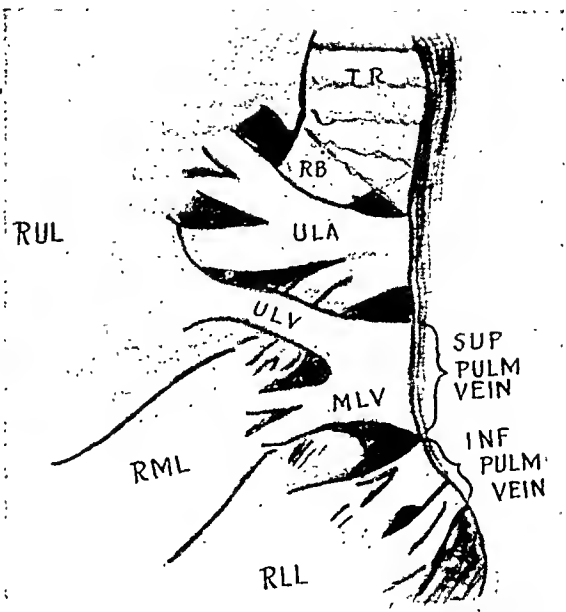


FIG. 23. Cadaver dissection of right hilar region by Kent and Blades. This diagrammatic anterior view shows the middle lobe vein as a tributary of the superior pulmonary vein lying anterior to the pulmonary artery and its branches.

The full thickness of the wound edge on either side is protected by a laparotomy sponge before the rib retractor is applied.

**Bronchus Divided.** The anesthetist allows a partial collapse of the right lung which is retracted anteriorly with stick sponges. The posterior reflection of the pleura over the hilum is divided; and the bronchus, which may be identified by the palpable cartilaginous rings, is isolated between the orifices of the upper lobe and the middle lobe bronchi. Stripping of the bronchus proximal to the contemplated site of division is avoided. The bronchus is steadied with a large kidney pedicle forceps. (Fig. 14.)

The correctness of the level at which the bronchus has been exposed may be verified by compression of the bronchus while the anesthetist attempts to re-expand the lung. A selective re-expansion of the upper lobe is confirmatory. A sufficient margin of right stem bronchus is allowed to remain to permit closure without obstruction to the upper lobe bronchus. Stay sutures are inserted to control the proximal stump of the bronchus, a distal tie is made and the bron-



FIG. 24. Fissure completed by division of pulmonary tissue between Ochsner clamps.

FIG. 25. Inferior pulmonary vein exposed and first ligature applied.

FIG. 26. The second and third ligatures applied to the inferior pulmonary vein.

FIG. 27. Pulmonary vein divided leaving two ties on the mediastinal side.

chus is ready for division. (Fig. 15.) The tie on the distal segment of the bronchus prevents the escape of secretion from the lower lobes, and the secretion present in the proximal stump of the bronchus is quickly

removed by aspiration. (Fig. 16.) Bleeding from a bronchial artery may be active when the bronchus is divided, and the artery may require clamping and ligation with quilting cotton.



FIG. 28. The right middle and lower lobes removed. The dissector indicates the ties on the stump of the inferior pulmonary vein.

FIG. 29. The dissector indicates the ties on the pulmonary artery and the sutured bronchial stump. The pleural flap remaining from the incision into the pleura over the hilum lies posteriorly in folds.

*Closure of Bronchial Stump.* Airtight closure of the stump of the bronchus is effected by four or five interrupted sutures of catgut, No. 00 chromic, on an atraumatic needle. Mattress sutures may be employed, but an effort is made to produce minimal impairment of the bronchial stump circulation. (Figs. 17 and 18.)

*Ligation and Division of Pulmonary Artery.* The pulmonary artery is next sought and isolated by gentle, blunt dissection, and sufficient of its branches are exposed to insure preservation of the blood supply to the upper lobe. (Figs. 19, 20 and 21.) The dissection of the hilum may be rendered difficult by the presence of enlarged adherent lymph nodes.

The artery is ligated proximal to the branch or branches to the middle lobe by means of a silk tie, after which a similar tie is placed distally allowing an interval of about 1 cm. between. If the artery bifurcates in this interval, the branches may be tied separately. (Fig. 22.) A stick tie is then applied to the artery just distal to the proxi-

mal tie, and after this is secured the artery is divided below it leaving a small cuff proximally. No. 18 silk has been used usually for the free ties on the artery and No. 5 silk for the transfixion ligature.

The vein from the middle lobe, usually a tributary of the superior pulmonary vein, lies anterior to the artery (Fig. 23), and it is isolated, tied and divided in a manner similar to that employed for the artery. Anatomical variations in artery and vein patterns are common and care must be used in the identification of the vessels included in the dissection.

The middle lobe is now separated from the upper lobe by division of the intervening pulmonary tissue between Ochsner clamps. (Fig. 24.) The wound in the upper lobe is closed by a double row of continuous fine catgut sutures on an atraumatic needle.

The middle and lower lobes now remain attached to the mediastinum by the inferior pulmonary ligament and the inferior pulmonary vein which it contains. The isolation of



FIG. 30. Pleural flap sutured over bronchial stump.

FIG. 31. Right upper lobe re-expanded by anesthetist.

FIG. 32. Wound reinspected after irrigation.

FIG. 33. Finochietto rib retractor about to be removed from chest; right upper lobe expanded.

the inferior vein is facilitated by an incision in the lower margin of the inferior ligament and gentle dissection upward with the finger introduced through the opening in the ligament. Care is exercised not to produce a tear in the thin wall of the vein as the liga-

ment is divided and the vein is cleared of as much of the adjacent tissue as possible. A No. 18 silk, free tie is applied to the vein at the most proximal point in its exposure. (Fig. 25.) A stick tie of the same material is applied just distal to the first tie (Fig.

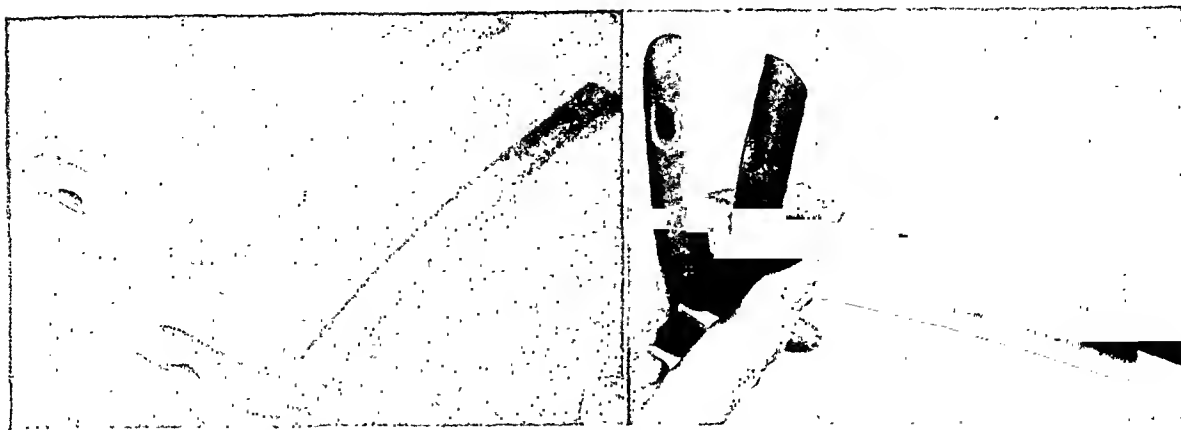


FIG. 34. Rubber angle drains; above as purchased; below as refashioned before use.  
 FIG. 35. Angle drains; left as purchased; right before use.



FIG. 36. Posterior angle drain inserted by withdrawal through stab wound.  
 FIG. 37. Large hemostat follows points of scissors into chest through anterior stab wound.  
 FIG. 38. Anterior drain withdrawn through stab wound.



FIG. 39. Anterior and posterior drains in place.

FIG. 40. Heavy pericostal silk suture about fifth and seventh ribs has been drawn up and tied to close wound, while smaller interrupted nylon sutures are tied closing the wound in the rib bed.

FIG. 41. Heavy silk suture cut out and reconstruction of chest wall muscles started.

FIG. 42. Closure of auscultatory triangle.

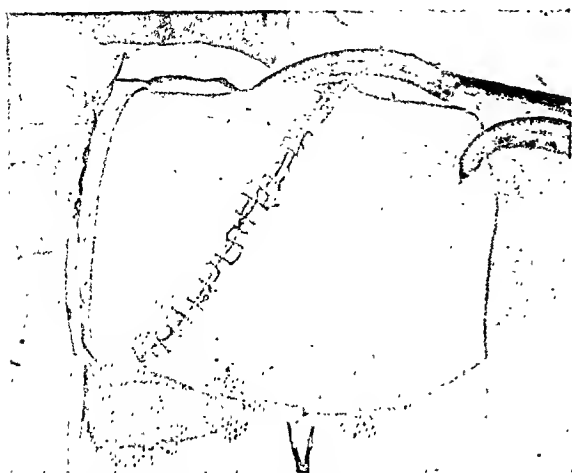


FIG. 43. Wound closure completed; chest drains will be connected to water seal after lung is re-expanded.

26), after which a third tie is made sufficiently distalward to permit division of the vein between ties No. 2 and 3.

The vein is then cut and the lobes are removed from the chest. (Figs. 27 and 28.) (In Figure 28 the tie on the inferior vein is indicated. In Figure 29 the ties on the artery and the closure of the bronchus are pointed out.)

**Pleural Graft.** The leaf of pleura remaining from the posterior incision of the hilum is brought anterior as a flap to cover the bronchial stump. It is secured in place by several interrupted sutures of fine catgut. (Fig. 30.)

**Insertion of Drains.** Before the bronchus is covered by the pleural flap, it may be tested for the airtightness of the closure by increase in the pulmonary pressure produced by the anesthetist. With the pleural graft placed, the anesthetist inflates the upper lobe (Fig. 31) and the suture line in the upper lobe is again inspected for adequate closure.

Any blood or secretion which may have escaped into the chest is removed by irrigation with normal saline and aspiration. If the surgeon elects to produce a temporary paralysis of the right diaphragm, it is done at this stage by crushing the phrenic with the points of a hemostat where the nerve courses over the pericardium. A final check for hemostasis (Fig. 32) is made and the rib retractors are removed. (Fig. 33.)

A No. 45 French rubber, angle drain, the tip of which has been cut off and in which a new opening has been cut (Figs. 34 and 35), is now inserted in the posterolateral chest through an intercostal space about 3 cm. above the costophrenic angle.

The skin incision for the drain is of such size that it will fit snugly about the drain when inserted. The incision is made with a scalpel over the tip of a heavy scissors which has been forced outward through the selected intercostal space. A long curved hemostat follows the scissors into the chest through the incision so made, and the drain is drawn out through the opening by the withdrawal of the clamp. (Fig. 36.)

A second drain of the same type is inserted through the fourth intercostal space anteriorly, the wound being placed sufficiently far lateralward to avoid the nipple and the breast tissue. (Figs. 37 and 38.)

The drains are left open (Fig. 39) until the chest wall has been closed and the remaining upper lobe is reexpanded, at which time the drains will be clamped off.

**Closure of the Chest.** A length of doubled heavy silk is inserted as a pericostal suture below the seventh rib at about the midpoint of the wound. It is brought out above the fifth rib and the needle is cut out. This suture is anchored and not yet tied. A series of interrupted No. 2 nylon sutures are now placed in the margins of the pericostal bed and pleura. These sutures are individually anchored in clamps.

The edges of the wound are brought into apposition by pulling up and tying the heavy silk suture first inserted. The sutures inserted in the rib bed and pleura are tied individually; after this part of the closure has been completed, the heavy silk pericostal suture about the ribs is cut and removed. (Fig. 40.)

Interrupted nylon sutures are used to reconstruct the muscle wall. (Figs. 41 and 42.)

The skin incision is closed with interrupted cotton. (Fig. 43.)

The upper lobe is re-expanded by the





FIG. 44. Postero-anterior x-ray study of chest following instillation of iodized oil into right bronchial tree.

FIG. 45. Oblique bronchogram of right chest.



FIG. 46. Right lateral bronchogram; involvement of the right middle and lower lobes is seen. In a subsequent preoperative study better filling of the upper lobe showed it to be uninvolved.

anesthetist, and the drains are clamped off until they are attached to tubes extending under water in gallon glass jars with two-hole stoppers.

If indications for bronchoscopy are present, this is done before the patient leaves the operating room.

#### CASE REPORT

The patient, a thirty-five year old Army officer, was admitted to the hospital February 6, 1946, as a transfer from another Army hospital with the diagnoses: (1) cyst, pulmonary, right lower lobe and (2) bronchiectasis, right lower lobe, severe.

The history revealed the usual diseases of childhood with complete recovery from each. In addition the patient had diphtheria at the age of three, pneumonia at the age of five and scarlet fever at the age of seven. The patient believed that the pneumonia was bilateral and he believed that some fluid was aspirated from the right chest. He made a complete and uncomplicated recovery from his illnesses otherwise, and there were no known residuals or sequelae. The officer went on active military duty on October 17, 1941.

About February 1, 1944, while on military



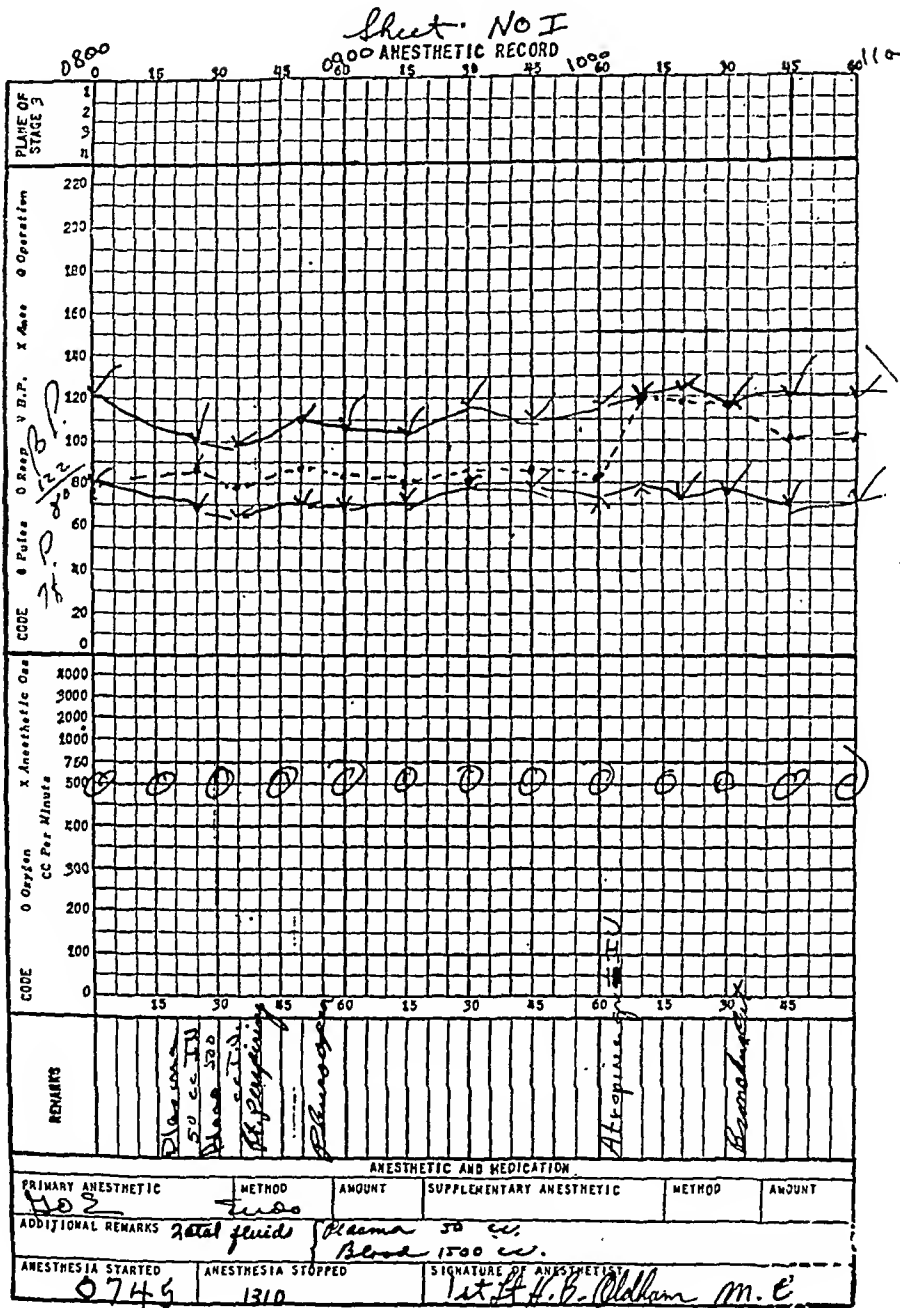


FIG. 47

FIGS. 47 and 48. Graphic record of anesthesia. The upper and lower solid lines, punctuated by V's, indicate the course of the patient's systolic and diastolic blood pressures. These started at 122/80 and were without significant change during the operation. The dotted line indicates the patient's pulse, starting at 80. The pulse was sharply accelerated to 120 at 10:00 o'clock (see top of graph) when

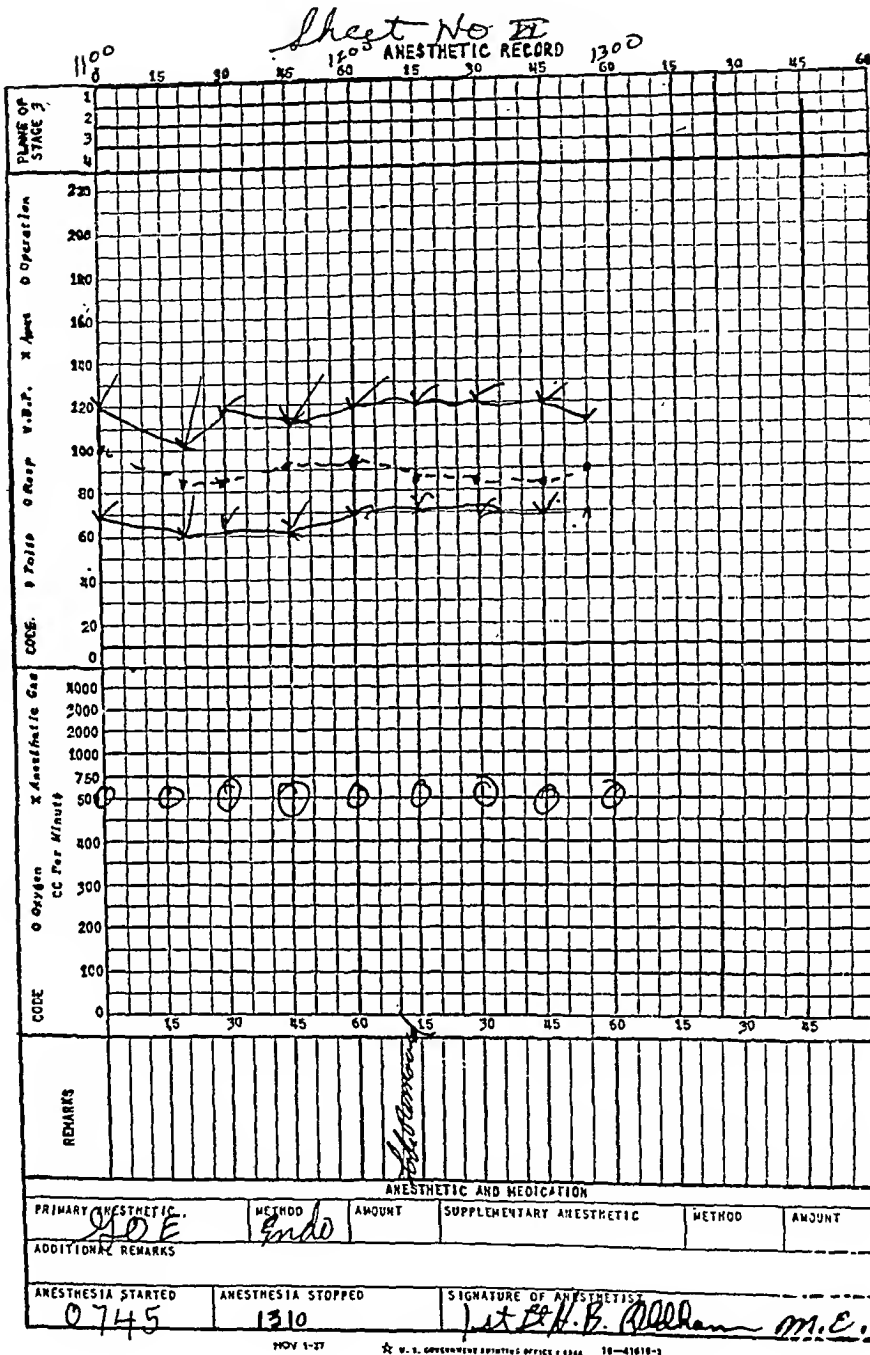


FIG. 48

atropine sulfate,  $\frac{1}{100}$  gr., was given intravenously as dissection of the bronchus was begun. The O's of the lower line indicate that the patient received 500 cc. of oxygen per minute during the operation, together with sufficient nitrous oxide and ether for adequate anesthesia.

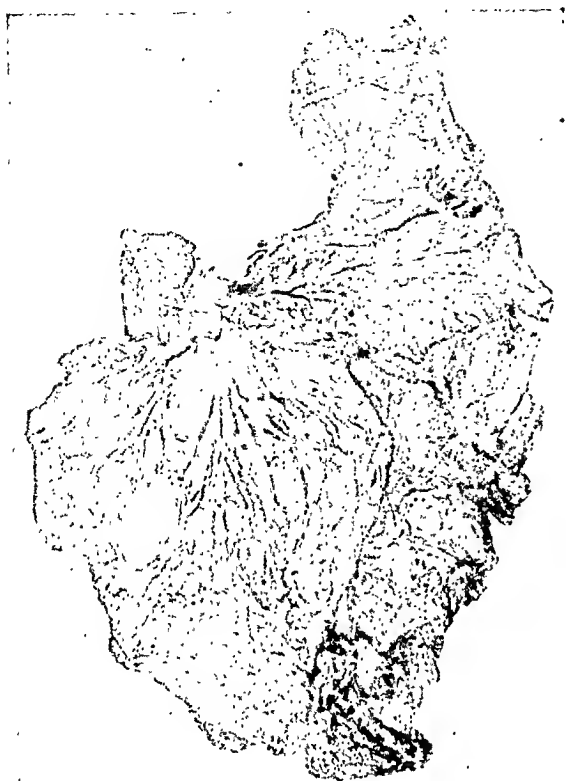


FIG. 49. Dissection of specimen removed at surgery; numerous bronchiectatic, cyst-like lesions are seen. Microscopically, there is increase in connective tissue about the bronchioles with little evidence of acute inflammation.

duty in the Southwest Pacific, the patient noticed the onset of weight loss, shortness of breath, dizziness and feverishness. There was also a mild cough which was productive of a small amount of non-purulent sputum. With the persistence of these symptoms, the patient was first hospitalized about one week later. Treatment included the administration of oxygen, sulfonamides and bed rest. X-ray studies of the chest revealed evidences of bronchiectasis in the right lower lobe, but on May 25, 1944, he was sufficiently improved to return to duty. On June 30, 1944, the same symptoms which had previously occasioned hospitalization recurred except that at this time the cough was productive of 1 to 2 ounces of purulent sputum per day. The officer was again hospitalized on that date and after one week of further treatment with sulfonamides, he returned to duty improved. The cough and sputum persisted and climatic changes produced recurrences of fever and dizziness.

Blood began to appear in the sputum with a hemorrhage in August of 1945. Further

hemorrhages occurred at intervals of four to six weeks, with continuous blood streaking between. The quantity of blood lost ranged up to 6 ounces and the quantity and foulness of the sputum were increased following these episodes. Bronchograms were made on August 20, 1945, and these were interpreted as showing bronchiectasis in the right middle and right lower lobes. The officer continued on duty until January 5, 1946, when, following his return to the United States, he entered a military hospital.

The patient's civilian occupation was athletic coach. The family history was non-contributory. There was a nasal operation in 1929 with no other surgery and no serious injuries.

Physical examination revealed a healthy appearing white male, 5 feet 11 inches tall, weighing 184 pounds. Physical examination of the chest revealed decreased tactile vocal fremitus in the right lower posterior chest, decreased breath sounds in the same area and dry râles throughout the right lower posterior chest with some inspiratory wheezes. The blood pressure was 128/98. In the remainder of the physical examination the findings were normal.

The blood Kahn was negative on February 7, 1946, and on the same date the white blood count was found to be 6,000 with 47 per cent neutrophils, 50 per cent lymphocytes and 3 per cent eosinophiles. The hemoglobin was 104 per cent, 16.2 Gm. The urinalysis showed normal findings with the color yellow; specific gravity 1.026; character, clear; reaction, acid; albumin, negative; and sugar, negative. Examination of the sputum by smear and culture on February 11, 1946 was negative for acid-fast bacilli. The conventional x-ray study of the chest on February 7, 1946, was interpreted as revealing, "marked bullous emphysema in what appears to be the right middle lobe, with atelectasis and bronchiectasis involving the right lower lobe."

Bronchoscopy was performed on February 11, 1946. This revealed a generalized hyperemia of the tracheal and bronchial mucous membrane on both sides. The carina was somewhat thickened. There was a generalized distribution of a thin, mucoid type of secretion. There was no evidence of tumor, stenosis, granulation tissue or foreign body.

Bronchograms made on February 16, 1946, revealed the right middle and lower lobes to be honey-combed with bronchiectatic cysts. (Figs.

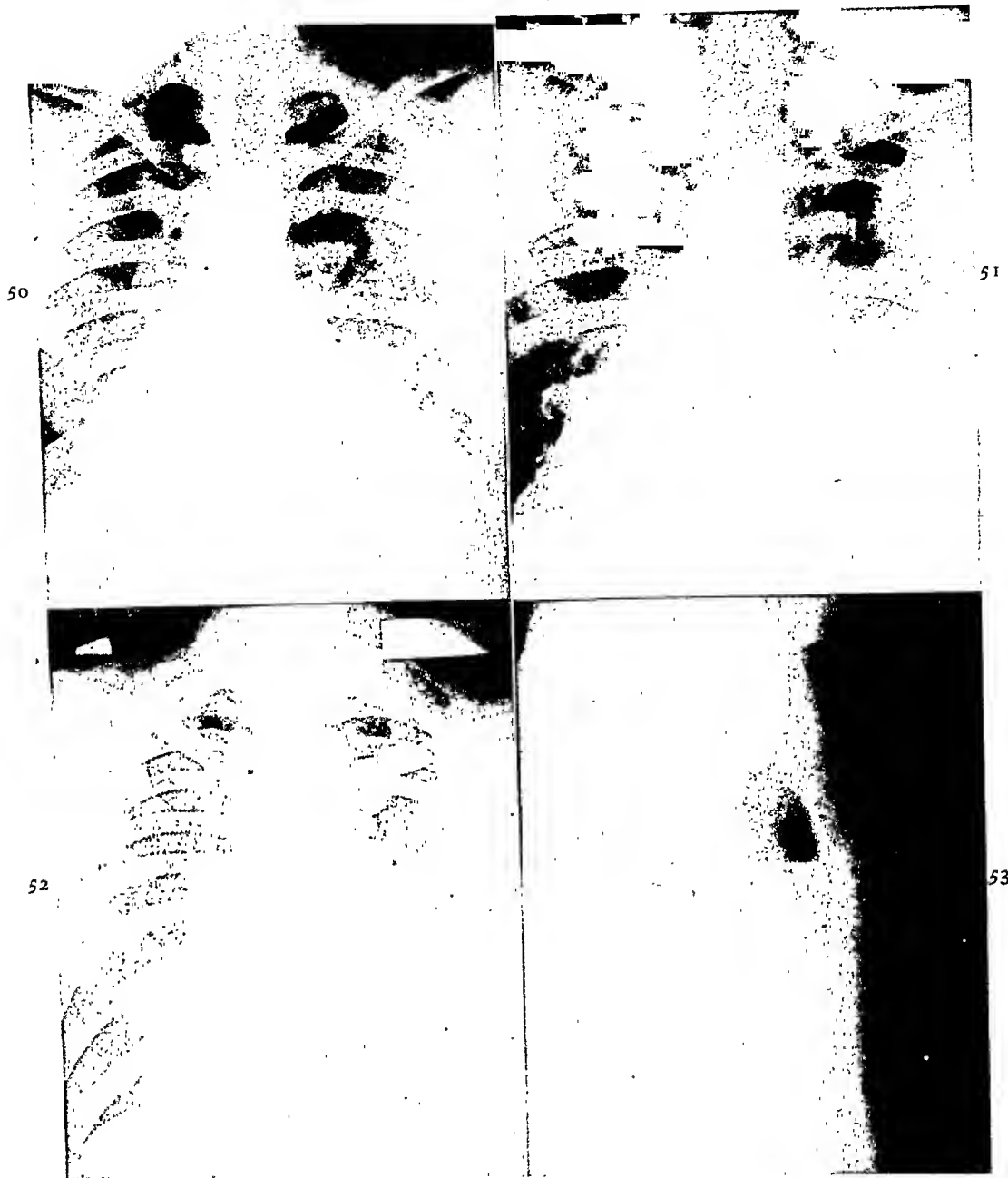


FIG. 50. Bedside postero-anterior x-ray of chest two days after lobectomy (April 5th). The rib resection and elevation of the right diaphragm are evident and a patch of possible bronchopneumonia appears at right base. Residual oil from the bronchographic studies remains.

FIG. 51. Bedside x-ray of chest on fourth postoperative day; pleural reaction appears quite marked; the pneumonic process is less evident.

FIG. 52. Fluid level right chest, seventh postoperative day (April 10th).

FIG. 53. Right lateral x-ray of chest showing fluid level (April 10th).

44, 45 and 46.) The remainder of the lung fields appeared to be normal. Repeat bronchograms were performed on February 27, 1946, to better demonstrate the right upper lobe and no involvement of this lobe was found. On February 18, 1946, the ears, nose and throat were again

examined with normal findings, and on the same date a dental survey revealed the condition of the teeth and mouth to be satisfactory.

On March 25, 1946, following a leave, the patient was admitted to a surgical ward and was started on penicillin. This was given by



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FIG. 54. Postoperative bronchogram, postero-anterior; the usual postlobectomy changes are present in the right chest with no evidence of residual bronchiectasis.



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FIG. 55. Oblique bronchogram of right chest; the right upper lobe has expanded to fill the right chest.



FIG. 56. Right lateral bronchogram.

intramuscular injection, 20,000 units every three hours.

On April 2, 1946, the patient was given  $1\frac{1}{2}$  gr. of nembutal at bed time. The blood which was Rh positive had been matched and typed, and blood suitable for transfusion was on hand. Three gr. of nembutal were given at 5:30 A.M. on April 3, 1946, followed by  $\frac{1}{4}$  gr. of morphine sulfate and  $\frac{1}{100}$  gr. of atropine at 6:45 A.M. Operation was started at 8:20 A.M. under endotracheal gas, oxygen and ether.

The previously described operation for resection of the right middle and right lower lobes was carried out. (Figs. 47 and 48.) During the operation the blood pressure ranged within the following limits: systolic, 100 to 120; diastolic, 64 to 80. Plasma was started intravenously with the beginning of the operation. Fifteen minutes after the start of the operation the plasma intravenously was replaced by blood, and a total of 500 cc. of blood was given during the operation. Forty minutes after the start of the operation, the pleura was opened without noteworthy change in the blood pressure, pulse or respirations.

At 10:00 A.M. the patient was given  $\frac{1}{100}$  gr.

of atropine sulfate intravenously while the bronchus was being dissected. An acceleration of the pulse rate to 120 followed. At 10:30 the bronchus was cut. At 12:10 the lobes were removed from the chest (Fig. 49.), and at 12:55 the chest wound closure had been completed and the patient was bronchoscoped. There was a moderate amount of secretion in the tracheobronchial tree. After this had been removed by aspiration through the bronchoscope the patient was returned to the ward in good condition.

Immediately following the return of the patient to his room, he was placed in an oxygen tent. The drains from the chest which were connected with water-seal jars in surgery were checked at the bedside and were found in satisfactory working condition. Two cc. of demerol were given as needed for pain at intervals no closer than every three hours. The blood pressure and pulse rate were noted at half-hour intervals, and after the patient had aroused from the anesthesia at 7:30 P.M. he was sat up and "coughed" every two hours. The oxygen was discontinued at 10:30 P.M. The patient continued to receive penicillin on the same schedule as preoperatively.

As soon as the patient was able to swallow, he was started on sulfadiazine, 15 gr. (1 Gm). every four hours. This was continued for seven days. The patient's highest postoperative temperature was recorded on April 5th at which time the morning temperature was 99.6°F., pulse rate 92 and respirations 22. The following is the report of the radiologist on the bedside film on April 5, 1946 (Figure 50):

"Partial right rib resection. Probably incomplete expansion, remaining right lung which is difficult to evaluate on present bed-side study. Bronchopneumonic patch right cardiophrenic area. Soft tissue emphysema, right hemithorax laterally and in the cervical area. Residual opaque oil, left lung field. Moderate elevation, right diaphragm."

Bedside bronchoscopy was performed on April 6, 1946. Visualization of the right bronchial stump showed it to be healing satisfactorily, and a moderate quantity of

mucosanguineous secretion was removed by aspiration. A bedside x-ray made the following day (Fig. 51) showed some improvement in the pneumonic process, but further x-ray studies made on April 10, 1946, (Figs. 52 and 53) showed the presence of pleural fluid on the right. The right chest was aspirated on April 11th, April 13th, April 15th and April 17th. On April 11th, 70 cc. of slightly blood-tinged serum was obtained. On April 13th, no fluid was obtained. On April 15th, 6 cc. was removed, and on April 15th the tap was again dry. Culture of the aspirated fluid revealed no growth. Bedside physical therapy was started on the first postoperative day and this was continued throughout the patient's convalescence.

On the patient's second postoperative day the drainage tubes were removed from the chest and the patient was allowed out of bed for short intervals. On the third postoperative day he was given bathroom privileges. The sutures were removed from the skin incision on the eighth postoperative day. On June 12, 1946, following the patient's return from a convalescent leave, bronchograms were again obtained and these revealed no evidence of residual bronchiectasis. (Figs. 54, 55 and 56.)

On August 1, 1946, the patient left the hospital for "temporary limited" duty with re-examination scheduled in about six months. At the time of discharge from the hospital the patient was free from cough and sputum, and he had no complaints other than mild shortness of breath and numbness of the skin anterior and inferior to the thoracotomy scar, both of which symptoms were gradually subsiding.

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# FOUR HUNDRED CONSECUTIVE CASES OF JAUNDICE\*

CARL A. BACHHUBER M.D. AND ALFRED E. GILBERT M.D.

*Los Angeles, California*

TODAY there are two classifications of jaundice which have received widespread consideration, namely, those by Rich<sup>1</sup> and McNee.<sup>2</sup> Rich in his classification divides jaundice into the regurgitation and retention types while McNee, whose classification is the more widely accepted, uses three divisions, namely, obstructive, toxic and infectious and hemolytic.

The latter has been criticized by Rich who states that the classification of McNee is based upon both clinical and etiologic factors using two standards within one classification. His objection is rightly stated, but until Rich's classification receives more generalized usage the one of McNee's will remain.

In accord with Rich's classification is the one offered by Yater, in that he divides jaundice into the obstructive and hemolytic groups. He further subdivides the obstructive group into the intrahepatic and extrahepatic groups thereby placing toxic and infectious jaundice into the intrahepatic obstructive group in which they rightfully belong. This is also in accord with the teaching of Rich.

The accumulation of bile pigments within the circulation producing an icteric color of the sclera and skin may have various etiologic factors. Volumes have been written, numerous tests devised and still with the exception of a few basic accepted principles the entire question is far from being solved.

On the differential diagnosis of jaundice much also has been written and many tests have been devised, all of which have little significant value if the proper clinical observation has been made. There are still no tests which will replace the proper

evaluation of a good history and physical examination. Certainly the daily observation of the stool as to color and the observation of urine will immediately give one a clue as to the type of jaundice with which the patient is afflicted. It is surely quite disconcerting to be called to see a patient with jaundice and see no daily observations recorded regarding the stool and urine.

The increase of the amount of bile in the urine or the changing color of the stool will afford pertinent information as to the advancement or retrogression of the etiologic factor producing jaundice. After the icteric changes of the skin have advanced to a certain point visual observation will give no further information as to the amount of bile pigment present in the circulation. And it is here that the icteric index or the serum bilirubinate determination is of some value. Nevertheless, even at this point, the observation of the stool and urine will still be of considerable diagnostic value. The assumption that the icteric index continues to rise to a given level as long as the stools are acholic is essentially correct. The changing color of the stool would definitely point to a fluctuating icteric index and would favor a diagnosis of lithogenic disease in place of pancreatic neoplasm.

The persistence of an acholic stool is significant of obstructive jaundice, be it intra- or extrahepatic in type. The release of the obstructive lesion would immediately manifest itself by a change in character of the urine and color of the stool, and would favor a diagnosis of lithogenic, toxic or infectious type of jaundice in preference to a neoplastic type.

The direct or indirect van den Bergh test has but little practical application if the

\* From the Surgical Service of the Los Angeles County General Hospital and Department of Surgery, College of Medical Evangelists, Los Angeles, Calif.

aforementioned observations have been diligently carried out; for the acholic stool with choluria and a cholic stool with acholuria would immediately place the icterus in one of the two main divisions.

There are many other tests and while a few are of some value as confirmatory evidence, they all are usually found lacking when one seeks aid in the finer differential points. Since all the tests used for jaundice deal with liver function, the value is greatly depreciated by the fact that each test evaluates but one hepatic function and since the liver possesses many functions the impairment of any one function is not necessarily indicative of the function of the organ as a whole. Furthermore, the liver has marked regenerative powers and there must be considerable impairment of function present before it reflects itself in the laboratory analysis. One must also appreciate the fact that it is seldom he is dealing with one form of jaundice alone; for with the hemolytic type sooner or later hepatic impairment will become evident thereby complicating what once was a hemolytic jaundice with an intrahepatic obstructive or regurgitant type of jaundice. Also an intrahepatic or obstructive type of jaundice will soon produce liver changes thereby complicating the picture with a retention type of jaundice.

Jaundice has also been classified into the painless and painful type, the painful group suggesting an inflammatory or lithogenic basis while the painless type presumes a neoplastic or toxic basis. While the presence or absence of pain is of some value in differential diagnosis, nevertheless a study of patients suffering from icterus reveals a surprising number who die from painless obstruction of the common duct due to a stone or, conversely, those who because of pain were subjected to surgery in consequence of a diagnosis or a common duct stone only to find a malignant lesion in the pancreas.

It is not unusual to find at surgery or at autopsy a common duct stone as a cause of jaundice which had previously been

diagnosed carcinoma of the head of the pancreas; conversely, a so-called common duct stone frequently proves to be a carcinoma of the head of the pancreas. Since this error is of frequent occurrence, it behooves one to perform an exploratory laparotomy in an effort to definitely determine the etiologic factor of the jaundice and to ameliorate or remove the fundamental cause of the affection if possible.

In this particular study we have reviewed the records of 400 consecutive patients suffering from jaundice as taken from the files of the Los Angeles County General Hospital. While a review of this type will produce statistics which are of some value in drawing conclusions, one must nevertheless be aware of the fact that due to the numerous uncontrollable variables encountered, namely, the failure to definitely establish all diagnosis through surgery or necropsy, we must be somewhat hesitant to accept the conclusions as being absolutely correct.

We must also recognize that diagnostic ability, even that of our best diagnostic institutions, is far from what might be desired. Furthermore, the large group of patients who have recovered and been discharged as having had a certain type of jaundice is no assurance that the diagnosis was correct. However, we are safe in assuming that patients so discharged as cured or improved were in their proper category as well as those who were dismissed in an unimproved condition and who showed a steady downhill course. But it must also be remembered that all patients with jaundice are not hospitalized.

In certain groups, namely, the lithogenic and neoplastic of the pancreas, sufficient patients were subjected to surgery or necropsy to correctly establish the diagnosis in a very high percentage of cases.

In presenting the following tables we have divided the four hundred patients into seven groups. (Table 1.) While we realize that the classification is far from ideal and certain rearrangement might be advisable, nevertheless, it at least presents



a working basis for presentation of the statistics.

In reviewing the group as a whole it immediately calls forth the observation that an individual who becomes jaundiced has approximately three and one-half of

moval of the gallbladder with its contained stones before the onset of malignancy would spare a high percentage of these patients. It is the only procedure which would give permanent relief for all other surgical procedures are only palliative in character.

TABLE I

	Total	Per Cent
Malignancy.....	175*	43.75
Common duct stone.....	86	21.50
Inflammatory.....	64	16.00
Hemolytic.....	38	9.50
Portal cirrhosis.....	20	5.00
Unknown.....	11	2.75
Stricture.....	6	1.50
	400	100.00

\* Includes two patients with Hodgkin's disease.

ten chances to recover. For as we appraise the mortality of the various groups it is quite apparent that the inflammatory group, which includes catarrhal jaundice, offers the patient the best opportunity to recover but in the remaining groups the mortality gradually increases, reaching a 100 per cent in the malignant group.

**Malignancy.** In this group we have one hundred seventy-five patients who suffered from malignancy, or 43.75 per cent of the total. This immediately brings the patient's chance of recovery to a 5.5 to 4.5 basis, or a little better than an equal break. (Table II.)

Carcinoma of the head of the pancreas leads the list as a cause of jaundice and accounts for approximately 25 per cent of cases, or about one in four. Coupled with the percentage of common duct stones, which is second in the list as a cause of jaundice with a total of 21.50 per cent, these two groups are responsible for approximately one-half of the jaundiced patients. (Table III.)

Neither medicine nor surgery has much to offer the malignant group. The presence of gallstones in a high percentage of malignant gallbladders offers a surgical incentive for reduction of the mortality for the re-

TABLE II  
MALIGNANCY

	Total	Per Cent of Malignancy	Per Cent of Total
Carcinoma of head of the pancreas.....	94	53.71	23.50
Carcinoma of biliary tract.....			
Gallbladder ducts and papilla of Vater.....	36	20.57	9.00
Metastatic Carcinoma to liver	32	18.29	8.00
Pressure on duct (two Hodgkin's disease).....	12	6.86	3.00
Carcinoma of duodenum.....	1	.57	.25
	175	100.00	43.75

TABLE III

	No.	Per Cent of Total
Common duct stone.....	86	21.50

In twelve instances in the malignant group jaundice was ascribed to pressure on the biliary ducts by a malignant lesion including two cases of Hodgkin's disease. While this group represents the total in which extrahepatic ductal pressure produced jaundice, we must recognize the fact that the remaining number represent intrahepatic ductal pressure. It is generally conceded today that malignancy neither primary nor secondary will produce jaundice without pressure on the intra- or extrahepatic ducts. All of us no doubt have seen necropsies at which almost the entire liver was replaced by carcinomatous tissue and still no jaundice ensued. Carcinoma of the head of the pancreas if present can expect little but palliative care. While it is true that in recent years surgical

procedures have been devised for the removal of pancreatic malignancies, still the outcome at present, at least, is very disappointing. However, it is believed that with improvement of diagnostic means and surgical technic the outlook for these patients may become more hopeful.

*Common Duct Stone.* In the second group we are dealing with common duct stone. This group accounts for more than one-fifth of the entire series. From a medical and surgical standpoint it is groups two, three, four and six which offer the patient a little more than palliation, but in the inflammatory group, be it lithogenic or nonlithogenic, and the hemolytic group the patient can derive medical or surgical relief.

However, surgery for common duct stone in the presence of jaundice carries a high mortality. These patients usually are in the elderly age groups, frequently suffering from some concomitant disease, who have done nothing over the period of years to alleviate their suffering from gallbladder disease until jaundice appeared. Frequently these patients have been told, even when aware of the presence of stones, that surgical removal is not indicated unless they are subject to recurrent attacks of colic or inflammation.

There is no doubt that gallstones should be removed when first discovered. This applies equally to the gallbladder with the solitary or so-called silent stone as well as to the gallbladder filled with numerous pigmented or cholesterol stones with recurrent attacks of acute cholelithiasis and cholecystitis. While it is true that the solitary type of stone usually is evidence against a common duct stone, nevertheless this is a vicious type of stone which undoubtedly is responsible for many of the serious cases of jaundice due to ascending cholangitis and, incidentally, to many perforations.

*Inflammatory* Undoubtedly the most hopeful group in this series is the group suffering from catarrhal jaundice for here the recovery is 100 per cent. (Table IV.)

Since there were no deaths and no surgeries, diagnosis rests solely on clinical observation and obviously upon the fact that the patient recovered. This disease is seldom found in the patient past thirty; it is usually in the twenty to thirty year

TABLE IV

	No.	Per Cent	Per Cent of Total
Catarrhal jaundice.....	31	48.44	7.75
Cholangitis.....	28		
non-calculous.....	16	25.00	4.00
calculous.....	12	18.75	3.00
Weil's disease.....	2	3.13	.50
Inflammatory edema.....	1	1.56	.25
Chronic pancreatitis.....	1	1.56	.25
Lues.....	1	1.56	.25

group. One must be rather reluctant to make this diagnosis in an individual past fifty years of age. All patients in this group but two were below thirty-two years of age.

The diagnosis of this type of jaundice is usually readily established with a fair degree of certainty, without surgical or autopsy findings. The type of onset, age group, rapid course, mild gastrointestinal symptoms and the early recovery of the patient is the picture ascribed to catarrhal jaundice. Frequently time plays an essential part in establishing diagnosis.

Cholangitis, which is usually secondary to an inflammatory lesion of the extra-hepatic biliary system, either calculous or non-calculous, comprised 43.75 per cent of this group or 7 per cent of the total. It is in this group, of course, that surgery is at its best, offering the patient a cure with but a low surgical mortality. Its presence can usually be diagnosed with a fair degree of accuracy because of the history of gallbladder disease or repeated attacks of biliary colic accompanied with a tender, upper, right quadrant, temperature, chills and leukocytosis. If the patient is closely watched and surgery instituted at the proper time, low mortality will be encountered. The best prophylaxis, however, is removal of the gallbladder and its con-

tained stones at the proper time when the diagnosis is first established.

Two patients who suffered from Weil's disease and who recovered, one with inflammatory edema in which necropsy established the diagnosis, one suffering

TABLE V  
TOXIC AND HEMOLYTIC ICTERUS

	No.	Per Cent	Per Cent of Total
Hemolytic.....	23	60.53	9.50
acquired.....	10	.....	2.50
congenital.....	13	.....	3.25
Toxic.....	12	31.58	3.00
arsphenamine.....	4		
phosphates.....	1		
sulfonamides.....	7		
Transfusion.....	2	5.26	.50
Massive pulmonary hemorrhage.....	1	2.63	.25

from chronic pancreatitis in which the diagnosis was established surgically and one patient with luetic jaundice comprise the remainder of this group.

*Toxic and Hemolytic Icterus.* Toxic and hemolytic icterus composed thirty-eight of the total, or 9.50 per cent. (Table v.)

This probably represents the next most hopeful groups because a high percentage of these patients can be given medical or surgical relief or cure. It is well known that in congenital hemolytic icterus splenectomy will stem the progress of the disease. In the acquired type of hemolytic icterus the etiologic factor will determine the patient's possibility of receiving either medical or surgical aid. In approximately 50 per cent of these patients the diagnosis was confirmed by autopsy or surgery.

With the advent of sulphonamides, one must always be on the lookout for a toxic reaction for the possibility of the icterus being on a toxic basis does exist. But the ultimate outcome, if the drug is promptly discontinued and medical measures instituted, is quite satisfactory.

Arsphenamine reactions, as far as icterus is concerned, are seen less and less frequently because of improvement of technic

and dosage. It is quite likely that with but few exceptions this type of jaundice will become less frequent. However, the question of permanent liver damage due to an overdose of an arsenical is always a possibility.

TABLE VI  
PORTAL CIRRHOSIS

	No.	Per Cent of Total
Portal cirrhosis.....	20	500

In spite of the improvement of technic an occasional reaction from blood transfusions will occur. But with the advent of a wider knowledge of the Rh factor and proper grouping of the blood and cross matching, it is quite likely the icterus resulting from transfusion will rarely occur.

As a whole the outlook for a patient suffering from the toxic or hemolytic type of jaundice is quite encouraging.

*Portal Cirrhosis.* Portal cirrhosis represents 5 per cent of the total of the four hundred case histories reviewed. (Table vi.) Just why some patients suffering from this disease should become jaundiced and others should not remains a mystery. There is also some question as to the type of jaundice portal cirrhosis represents for the etiologic factor being unknown it is quite likely that it may be a mixed type of jaundice when present. The most accepted theory is that it is a nutritional deficiency secondary to alcohol or some unknown toxin. However, there are patients suffering from portal cirrhosis who have never used alcoholic beverages in any form; consequently, some other toxin beside alcohol must be considered as an etiologic factor. Suffice to say that the outlook for the group is poor and it is a question of only a few years when all will succumb to the disease.

*Unknown.* In the unknown group there were eleven, or 2.75 per cent of the total. (Table vii.) In reality this should be a

much larger group for frequently diagnosis was established for statistical purposes when a diagnosis of unknown etiology would have been more feasible. Naturally the patients that recover care little if the proper diagnosis has been established.

TABLE VII  
UNKNOWN

	No.	Per Cent of Total
Unknown.....	11	2.75

On the other hand, autopsies in all deaths and surgical exploration if indicated, if the patient is willing, would probably bring many of these cases within their proper classification.

Strictures. The final group, namely, those of stricture again represent rather a hopeless picture. (Table VIII.) Naturally a congenital stricture of the newborn means a mortality of 100 per cent. As to the acquired type the surgeon will have to assume the entire responsibility for the mortality in this group. The presence of a stricture which is not promptly repaired will lead to cirrhotic changes in the liver which definitely contributes to the mortality. The patients are usually poor surgical risks; the secondary surgical procedures consume considerable time, leaving the patient in an extremely precarious condition postoperatively. This type of complication usually can be avoided. The proper exposure of an anatomic structure and careful ligating or severing of same will avoid most of these accidents. Since most accidents occur in removing the gallbladder in a

retrograde manner, it behooves one to proceed with caution or still better remove the gallbladder from the fundus to the duct.

As long as the blood supply to the viscus has not been interrupted it may still be

TABLE VIII  
STRICTURES

	No.	Per Cent of Total
Congenital.....	1	0.25
Acquired.....	5	1.25

used for an anastomotic procedure, but with a preliminary ligation of the cystic artery the viscus must be removed for necrosis and gangrene are sure to follow.

#### SUMMARY

A patient who becomes jaundiced, regardless of age, has approximately three and one-half chances of ten to recover.

If the jaundice occurs in an individual who has reached middle age, his possible percentage of recovery is still smaller.

Removal of a gallbladder and its contained stones at the proper time after diagnosis has been established will reduce the number of deaths due to common duct stones, malignancy of the gallbladder and the inflammatory group due to calculous disease of the viscus.

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# REVERSAL OF CIRCULATION OF THE BRAIN

## PARTIAL REVERSAL IN FOUR HUMANS TREATED FOR PARALYSIS AND MENTAL CONDITIONS

GEORGE H. SCIARONI, M.D.

Chief, Surgical Staff, St. Agnes Hospital  
Fresno, California

PARTIAL reversal of the circulation of the brain for therapeutic purposes can be performed with reasonable safety to the patient. All patients thus far operated upon were of the hopeless type with little chance for spontaneous recovery. Results given herein indicate that reestablishment of blood supply to parts of the brain by reversal or partial reversal of the circulation is a rational surgical procedure. While surgery of this general type has previously been performed experimentally on healthy animals and while many reversals of circulation have been performed on human limbs, it is believed that this paper gives the first reported work on reversal of circulation of the human brain or on reversal of brain circulation for improvement of mental or of paralytic conditions.

For proper understanding of the operation a discussion of the anatomic and physiologic relationships is desirable. The surgical technic developed by the writer will be found somewhat similar to previous methods but with a few significant innovations. Notable is the preliminary stretching of the artery. Without this it is difficult or impossible to perform the reversal, especially in patients of the elderly, sclerotic type for which this therapy may be indicated.

While this operation may be a drastic one for mere treatment of high blood pressure, it is noteworthy that in every case a definite lowering of the blood pressure resulted.

*Blood Supply of the Brain.* The arterial supply of the brain anastomoses considerably. The venous drainage is remarkable

for its lack of symmetry. The capillaries of the brain possess considerable power of dilatation and contraction, more particularly under stimulation by carbon dioxide. To discuss brain disorders some detailed consideration of the brain circulation seems desirable.

*Arteries of the Brain.* The brain derives its blood supply symmetrically from the two internal carotid arteries and the two vertebral arteries. These four vessels unite in the anastomosis at the base of the brain known as the circle of Willis. From this circle arises part of the ganglionic system of brain arteries while the remainder of the ganglionic system and the cortical system of arterics arise as secondary branches that is, branches of arteries that are tributary from the circle.

Dorrance,<sup>13</sup> Saphir<sup>24</sup> and others have summarized literature on anomalies of the circle of Willis. In two cases of Saphir both posterior communicating arteries of the circle were either absent or small and without lumen. In his third case the right posterior communicating artery was absent, the right posterior cerebral artery receiving all its blood from the basilar artery and hence from the vertebral arteries. On the left side the left posterior cerebral artery was connected with the basilar artery only by a fibrous cord without recognizable lumen. It is, therefore, remarkable that this left posterior cerebral artery was supplied by an extra large, left posterior communicating artery. This, like many similar examples of arterial brain anomalies, indicates that the arteries of the brain have considerable adaptability when necessary.

While the circle of Willis undoubtedly aids the equalization of the arterial supply to the brain, there are many other important arterial anastomoses in the head. For example, Dorrance<sup>13</sup> claims that if a common carotid artery in man has been ligated, the flow through the corresponding internal carotid artery does not reverse but continues toward the brain although at about 50 per cent of the normal rate. The flow in the external carotid artery, however, has become retrograde as it must be able to supply the internal carotid with blood. Thus, the external carotid artery can receive blood from the corresponding artery on the opposite side. Also, there are unilateral anastomoses which assist such as between the inferior and superior thyroid arteries.<sup>2,13</sup>

Poor development of one carotid artery should always be looked for before attempting surgery of these vessels. Homans<sup>19</sup> and Guinard<sup>15</sup> each had one of their patients die following ligation of a common carotid artery and autopsies showed the opposite carotid to be only weakly developed.

From the surgical standpoint it may be pointed out that the left common carotid artery arises directly from the aorta. On the right side it is the innominate artery that bifurcates to form the right subclavian artery and right common carotid artery. For these reasons the right common carotid artery is somewhat shorter and more difficult to manipulate than the left common carotid. Accordingly, the author's double arteriovenous anastomosis presents more technical difficulties when performed on the right side of the neck, and more stretching of the artery is necessary before severing. Hence, it is noteworthy that although based only on the four cases to be described presently there seems to be more improvement in the mental condition of the patient when the operation is performed on the right side rather than on the left.

Since the days of Cohnheim, anatomic books have taught that the circulation of the brain is peculiar in that the ganglionic

system and cortical system of arteries do not anastomose and that the arterials of the two systems are "end arteries." Part of this error arose from the fact that it was based on study of the brains of non-human animals. Cobb<sup>11,12</sup> now states exactly the reverse for man: "There are no end arteries in the human brain. A red cell could travel from occipital to frontal pole if it had means of locomotion." Hence, a partial reversal of the brain circulation probably results, not in mere reversal of flow in circumscribed areas but rather, in a redistribution of blood flow throughout the entire intercommunicating network.

Even complete occlusion of both carotid arteries and both vertebral arteries need not result in death. As long ago as 1896, Hill<sup>16,20</sup> described such an "almost complete" occlusion in man resulting from a slow pathologic process without ill effects on the brain. More recently, Andreyev<sup>2</sup> found that in dogs, damaging effects on the brain were relatively slight if the four arteries were each cut and ligated several weeks apart. If all four were cut and ligated simultaneously, most animals died although a few might survive with considerable brain damage. The arterial anastomoses of the head and neck, therefore, possess considerable adaptability to take care of redistributed blood supply.

*Veins of the Brain.* The return flow of blood from the brain is not symmetrical. Many veins drain first into the venous sinuses which, because of their volume content, permit a limited expansion of brain tissue without increase of intracranial pressure. In most humans blood from the top of the brain flows to the superior sagittal sinus, eventually reaching the right jugular vein while blood from the deeper parts of the brain in which cerebral accidents are usually supposed to occur leaves through the left jugular vein. Therefore, unless the patient is believed to be one of those occasional subjects in whom the above arrangement is reversed, one may prefer first to reverse the circulation on the left side of the neck, particu-

larly since reversal may be performed on one side only if sufficient improvement results. Nevertheless, it will be further noted that of the four patients operated upon by the author by far the greatest improvement was found with the two who were operated upon on the right side although more cases are necessary to make this conclusive.

While the sinuses of the dura mater frequently communicate with each other, there is a distinct pathway of blood from each sinus destined to a certain internal jugular vein of the neck. The superior sagittal sinus commences at the foramen caecum, running backward near the top of the skull until it nears the internal occipital protuberance, deviates (usually) to the right and is continued as the right transverse sinus, finally becoming the right internal jugular vein. The inferior sagittal sinus courses backward in the central part of the skull, being named the straight sinus in its posterior part, and its blood then travels (usually) through the left transverse sinus to the left internal jugular vein.

The veins of the brain are devoid of valves. They leave the brain, pierce the arachnoid to empty into the various sinuses of the dura. The veins are named cerebral and cerebellar according to the region drained. The superior cerebral, middle cerebral and inferior cerebral veins drain external portions of the cerebrum; they empty into the superior sagittal, transverse, cavernous, sphenopartital and superior petrosal sinus. The great portion of the blood from this region of the brain passes thus (usually) into the right internal jugular vein.

The basal or deeper veins are formed by a union of the anterior cerebral, deep middle cerebral and inferior striate veins at the anterior perforated substance. These veins pass backward around the cerebral peduncles to empty into the internal cerebral veins or veins of Galen. These veins of Galen, which drain the deep parts of the hemispheres, are two in number. They are formed by union of the terminal

vein with the choroid vein at the intraventricular foramen and course backward parallel with one another between the layers of the tela choroidea, receive the basal veins as previously stated, then unite to form the great vein of Galen and end in the straight sinus. Blood from this entire group and hence from the deeper parts of the cerebrum largely finds its way (usually) into the left internal jugular vein.

#### REVERSALS OF CIRCULATION

*Previous Reversals of Circulation.* Reversal of the circulation in limbs has been practiced for many years with some success. As long ago as 1912, Bernheim<sup>6</sup> collected records of fifty-two cases in the literature, including six of his own. Fifteen were "successful." Since many of these operations were alternatives to amputation, this may be a fair record.

Later, Bernheim<sup>4,5</sup> described a woman who suffered from gangrene of early Raynaud's disease and in whom he reversed the circulation in all four limbs. Eighteen years later the woman was still in fair condition.<sup>5</sup>

A partial reversal in the head of a dog was described by Horsley:<sup>21</sup> "The cardiac end of the common carotid was sutured to the cephalic end of the external jugular vein in a medium sized dog. This specimen was removed after 39 days. The sutures are distinctly buried, though the endothelium over them is still transparent at places."

Similarly, Guthrie<sup>16</sup> described a dog which lived for five years after the anastomoses between the cardiac end of the right common carotid artery and the cephalic end of the right external jugular vein, and also between the cephalic end of the right common carotid artery and the cardiac end of the right external jugular vein. The dog had excellent health and was eventually killed in a fight with other dogs. Guthrie stated after the dog's recovery, "That the pressure in the vein was less than arterial was indicated by the rela-

tively slight pressure on the cephalic portion of the vein adequate to occlude the lumen. . . . By palpation it could be demonstrated readily that the pressure in the cephalic end of the right external jugular vein was greater than in the unoperated vein."

*Physiologic Arteriovenous Anastomoses.* Partial reversal of the brain circulation must lead to some arterial blood reaching the vena cava without first traversing capillaries. It is, therefore, in point that arteriovenous anastomoses may exist normally in ears, fingers, toes, accessory sexual organs and perhaps elsewhere both in animals and in man. For details of anatomy and possible physiologic value of such anastomoses reviews such as that by Clark<sup>10</sup> are available. Whether or not arteriovenous anastomoses occur normally in the brain appears not certain as yet although there is some evidence for it.<sup>3,23</sup>

#### REVERSAL OF BRAIN CIRCULATION A NORMAL OCCURRENCE

While the brain requires a continuous, rich supply of oxygen, it probably never has the momentary enormous oxygen requirement of active muscle. Thus, the brain capillaries seem fairly long. Forbes<sup>14</sup> in early skull-window experiments "saw no capillaries," but did see long "arterioles" and "venules" which disappeared into the brain substance and in which blood corpuscles passed only "in single file." These vessels were no doubt actually long capillaries.

Forbes observed in some of these vessels that blood corpuscles might come to a stop and then, after some oscillation back and forth (synchronized with heart and respiratory pulsations), reverse their direction of flow. Therefore, reversal of circulation in the brain is to some extent a normal physiologic occurrence.

*Pulsating Exophthalmos.* A theoretically possible complication from reversal of the circulation of the brain is pulsating exophthalmos due to increased pressure in the cavernous sinus. This clinical entity

has been described repeatedly, Martin and Mabon<sup>28</sup> claiming to have collected references to 812 cases from the literature. In all or nearly all these cases the internal carotid artery had burst or broken into the cavernous sinus. The internal carotid artery is essentially surrounded by venous blood in that sinus. Thus, exuded blood from the artery rapidly flows away through venous channels and does not have an opportunity to clot and check the hemorrhage. Exophthalmos is caused by the blood pressure developed in the cavernous sinus.

In the author's patients no such pulsation or exophthalmos developed. This was true even in his single case (Case 11) in which the reversal was performed on both sides of the neck. While exophthalmos is always a possibility, it is likely that reversal of the circulation is less serious from this standpoint than mere bursting of the internal carotid artery into the cavernous sinus. The latter condition short-circuits the blood thus giving rise to possible anemia or ischemia in addition to the increased pressure. Generally it is found that when venous channels carry arterial blood under pressure and if there is no disturbance of nutrition, the vessel walls tend to thicken sufficiently to hold the arterial pressure. Thus, it may well be that for the same increase of pressure in the cavernous sinus, the danger of exophthalmos is less with a reversal of circulation than with the mere short-circuiting of blood from a ruptured internal carotid artery. The appearance and subsequent clearing of pain in the right eye following operation on the patient in Case 1 tends to support this hypothesis.

*Clinic Pathologic Phase.* Ischemia is defined by a medical dictionary as "a local anemia due to mechanical obstruction usually from contraction of a blood vessel," but for the purpose of this article ischemia will be defined as the condition in a circumscribed area in which there is a diminished nutritive activity resulting in total or partial dysfunction of the cells involved. The disorder, therefore, may



vary from simple diminished function to complete necrosis of the cells.

The etiologic factors resulting in ischemic conditions in the brain are many, but the pathologic condition of the cells involved is essentially the same. While the onset of ischemia may be sudden and dramatic as in a "stroke," Alvarez<sup>1</sup> recently suggested that senile degeneration may result from gradual formation of tiny clots in the arterioles of the brain.

Blood-gas determinations indicate that the oxygen content of venous blood leaving the brain is more nearly constant than in venous blood returning from muscular tissue. Lennox<sup>24</sup> quotes data, including some of his own, which indicate that in many instances the oxygen content of venous blood leaving muscular tissue may be greater than of blood in the jugular vein. Exactly the opposite is claimed by Haldane<sup>17</sup> who states that muscular tissue consumes up to 80 per cent of the oxygen circulating through it while brain tissue consumes perhaps one-half as much of the circulating oxygen. The cases of Lennox were mostly humans subject to seizures, but determinations were made after "lying down fifteen minutes or longer," hence the muscle tissue of the patients in Lennox's cases required very little oxygen. In any event, results of both Lennox and Haldane are compatible with the hypothesis that while oxygen content of blood leaving muscle tissue may vary within wide limits, oxygen content in the cerebral veins is normally maintained at a fairly constant level.

Hence, any disturbance, circulatory or otherwise, which slows the flow of blood in all or in part of the brain may have serious effects. The cortical cells particularly undergo necrosis within a few minutes after complete or nearly complete anemia is established. Recovery may be possible if the anemia is not too nearly complete or not of too long duration.

The problem, then, is alleviation of ischemia with its panphasic pathologic consequences. A solution, therefore, is

the rehemotization of the area or areas involved.

*Improvement of Epileptics from Circulation Reversal.* Epileptic or other convulsions are often regarded as pathologic but in a sense convulsions are quasi normal. Asphyxia, strychnine or other drugs may produce convulsions in normal individuals. Consider the sleeping rabbit whose fur is slightly ruffled by the breath of a fox. The rabbit may instantly spring high into the air and then run away. The initial spring differs only in degree and duration from a pathologic convulsion yet it saves the animal's life. Similarly, if a person is suddenly burned at some point, there is an immediate involuntary movement to escape; such a movement is not greatly different from a Jacksonian fit, except that it serves an obviously useful purpose. Vomiting and sneezing may similarly be regarded as (at least often) useful convulsions.

In general terms, therefore, a convulsion is a sudden mobilization of the nerve cells to meet an emergency but it is directed by the subconscious mind. (Nevertheless, Freud and others have regarded tantrums, hysteria, etc., as sometimes conscious or at least semiconscious, especially if a useful purpose is served.) "If, however, we were to hazard a two-word guess concerning the fundamental element in the precipitation of seizures in epilepsy, it would be oxygen-lack."<sup>25</sup> Whether or not the seizure may partially relieve such oxygen lack, need not be discussed at this point.

If epileptic convulsions in a particular patient arise from or at least are precipitated by oxygen-lack, improvement is evidently possible as a result of the author's operation for reversal of brain circulation. Results to date with his single epileptic patient (Case iv) tend to support this prediction.

#### VARIABILITY OF BRAIN CIRCULATION

*From Mental Work.* Various parts of the brain appear to enjoy a substantial increase in circulation as well as increase in

number of injectable capillaries when that part of the brain is working. This has been found in the olfactory lobe of the brain after smelling ammonia, also in the visual tracts of the brain after a light has been flashed into the eye.<sup>36</sup> Again, performance of "mental arithmetic" increases cerebral blood flow.<sup>26</sup> This general principle is the basis of the "lie detector" which actually measures systemic blood pressure and is used in police investigations.

*From Nervous Control.* Therefore, the cerebral arteries and even capillaries according to recent investigations have the power to dilate or contract for control of blood flow. Nerve fibers have been traced along the arterial walls. It has been stated that these fibers are found on arteries 50 microns or more in diameter<sup>3</sup> or even 25 microns or more in diameter.<sup>11</sup> "In the pia, even the capillaries appear to be innervated."<sup>11</sup>

Thus, the brain vessels do not just passively carry whatever amount of blood the heart pumps to them. Wolff<sup>35</sup> states that when one common carotid artery in the dog is tied off, blood flow in the opposite internal carotid artery increases nearly 100 per cent. Increase in intracranial pressure would be expected to force blood out of the cranial vessels thus constricting them. While this indeed happens with very high intracranial pressures approaching the arterial pressure, more moderate pressures cause the cerebral arteries to dilate even if the systemic blood pressure has not increased.<sup>36</sup> Again, local mechanical pressure on a small portion of the brain may cause dilatation of vessels in that portion without affecting vessels in the remainder of the brain as shown by skull-window experiments of Wolff and collaborators.<sup>36</sup>

Forbes<sup>3,36</sup> made an often quoted statement regarding arteries of diameter of 50 microns or more when their sympathetic nerves are electrically stimulated at some distance from the artery itself. His statement is to the effect that cerebral arteries contract about 8 per cent of their diam-

eter while systemic arteries (as in the skin) contract about 80 per cent of their diameters. Some have concluded from this that cerebral arteries have little power of contraction, but if the electrical stimulation be applied directly to the wall of the cerebral artery itself practically 100 per cent contraction or almost complete occlusion results.<sup>36</sup>

Again, although flow of blood in the pial arteries slows when the common carotid arteries are both simultaneously occluded, there is an immediate increase in diameter although from the fall of pressure in these pial arteries a contraction would be expected on mechanical grounds alone. If within one-half a minute the carotids are released, the pial arteries dilate still more, even sufficiently to cause diapedesis.<sup>36</sup> Therefore, it appears that when it is necessary to maintain nutrition of the brain, the cerebral arteries can and do enlarge considerably.

*From Carbon Dioxide.* Under usual conditions the nutritional requirements of the brain do not change within such wide limits as is the case between active and resting muscle or between perspiring and cold skin. It is probably for this reason that many physiologic experiments, such as those just considered, have led some to conclude that cerebral blood vessels are relatively passive and do not dilate or contract excessively.

Lowered oxygen content, or especially increased carbon dioxide content of the blood, obviously must greatly increase the requirements of the brain for blood since the brain prefers to work under fairly uniform concentrations of those two chemical substances. Carbon dioxide appears, from various nerve section and other experiments, to have a powerful, direct action on the vessel walls themselves, even on the brain capillaries.<sup>3,36</sup> Carbon dioxide, therefore, seems to have a strong stimulating effect in every part of the brain, not merely in the so-called "respiratory center." Since the effect remains after extensive nerve section and thus appears to be at

least partly a direct effect, it has been referred to as "humoral" action.

For example, decreased ventilation of the lungs causes simultaneous increase in carbon dioxide content and decrease in oxygen content of the blood. Cerebral vasodilatation under these conditions may be so extreme as to increase the cerebral blood flow as much as four times, but with no change in flow through the external carotid artery, and actual decrease in blood flow through the leg.<sup>36</sup> This dilatation of the cerebral vessels is easily seen through skull-windows. Ether also appears to have a strong dilating effect on cerebral vessels<sup>3,36</sup> which agrees with the practical fact that ether has held well against all competitors as a safe anesthetic. So-called improvements are often only combinations of basal or induction or other anesthetics with ether.

It is apparent that if the brain circulation is really reversed completely the arteries would contain venous blood with its high carbon dioxide content and low oxygen content. Thus, the humoral reflexes would then tend to increase greatly the caliber of the arteries. This might not only permit release of clots or other obstructions, but in any event should permit increased blood flow since the veins, owing to their relatively thin walls, should not impede the circulation to the extent that is possible in sclerotic arteries. Veins do thicken eventually when carrying arterial blood under pressure, but should carry the blood for some years before becoming sclerotic. Hence, it appears that reversal of the brain circulation provides a possible means for substantial increase of the blood flow through the brain, and if high blood pressure in a patient is caused by resistance of sclerotic cerebral arteries, reversal of brain circulation may well permit reduction of the arterial pressure.

#### RELATION OF PARTIAL REVERSAL OF CIRCULATION TO THE CAROTID SINUS

In recent years, importance has been given the carotid sinus reflexes by occi-

dental medicine. Strangely enough, oriental ju-jitsu experts have known of these reflexes for many centuries.<sup>23</sup> They know that either a sharp blow or severe pressure against the carotid sinus (not just against the side of the neck or against the vagus nerve) may produce unconsciousness within a second or so. Men are uncomfortable when wearing high, stiff collars and some may faint when wearing them; this is probably due to irritation of the carotid sinus.<sup>3</sup>

Similarly, Dorrance<sup>13</sup> states that ligation of the internal carotid artery is more dangerous than ligation of the common carotid and explains this as partly a carotid-sinus effect. Ligation of the internal carotid artery tends to increase pressure within the sinus which is located at the point where the common carotid artery bifurcates to form the external and internal carotid arteries. Thus, reflexes are started which still further reduce the brain circulation, but ligation of the common carotid artery obviously reduces the intrasinal blood pressure, thus tending to dilate the cerebral arteries. In the author's operation the pressure in the carotid sinus on the operated sinus is necessarily reduced thus also tending to dilate cerebral arteries.

It is true that elaborate physiologic experiments by Heymans<sup>18</sup> and others, using attempts to control arterial pressure by head perfusion at constant pressure, have not uniformly shown a direct effect of pressure changes in the carotid sinus on cerebral artery caliber.<sup>3</sup> In any event, in the intact animal, pressure decrease in the carotid sinus tends both to raise the systemic blood pressure and also to constrict the peripheral vessels, hence the final result is to increase considerably the cerebral blood flow.<sup>3</sup> Skull-window experiments have shown that a fall in the systemic blood pressure produces dilatation of the cerebral vessels although, of course, fall of pressure in the carotid sinus does not institute all the reflexes concerned.<sup>3</sup>

The carotid sinus is also sensitive to increased carbon dioxide content of the

blood.<sup>3</sup> In the author's double arteriovenous anastomosis, venous blood (containing more carbon dioxide than arterial blood) is introduced into the carotid sinus on the operated side. Hence, reflexes are started which tend to improve the volume of the cerebral circulation.

#### PRINCIPLES OF BLOOD VESSEL SURGERY

Blood vessel surgery differs fundamentally from most other kinds of surgery. The severed vessels, instead of being ligated as is usual, must be opened and sutured. Thus, there is great chance for hemorrhage. Because of the damage to the blood vessels, together with the shock of operation, clotting within the operated vessels is always a danger. For that reason many surgeons recommend anticoagulants such as heparin in blood vessel surgery even though this increases the danger of later or secondary hemorrhage.

In the larger vessels, such as the common carotid artery and the internal jugular vein, the chance of clotting within the vessels is relatively reduced because of the rapid blood flow. Furthermore, the internal surface area of a vessel is proportional to its diameter, but the internal volume is proportional to the square of the diameter. Hence, in larger vessels there is proportionately less damaged endothelium to cause clotting of the blood but danger from hemorrhage is greater in larger vessels; therefore, also based on the writer's practical experience, he does not use heparin or other anticoagulants in surgery of the larger vessels.

There are two basic methods of uniting ends of blood vessels: end-to-end suture methods first popularized by Carrel<sup>7,9,27</sup> and invagination methods in which one vessel is slipped inside the second vessel. End-to-end methods may have the disadvantage that thread remains in contact with the flowing blood although Carrel reduced this effect by careful coating of the silk threads with petroleum oil to reduce clotting. Also, there are numerous

holes made by the needle which open directly into the blood stream and these offer chance for secondary hemorrhage, especially if infection develops. It is true that by the method of Zaaier<sup>32,37</sup> the sutures may be placed so that when tightened the ends of the vessels automatically dilate as flanges; no thread remains in the flowing blood but the vessels must then be flexible, as for example, veins. Furthermore, end-to-end methods lend themselves most readily to union of two vessels of about the same size, but the common carotid artery in man is much smaller than the internal jugular vein; it seems thus more logical to slip one vessel inside the other.

In the invagination method, the principle used by the writer, one vessel stump having perhaps been turned back over itself is slipped into the second vessel stump. This has the advantage that no needle holes need open into the blood stream directly, also that flowing blood need not necessarily touch any blood vessel substance except endothelium thus reducing danger of clotting inside the vessels. The turning back process has been omitted partly because it may damage the vessel. Furthermore, in most of the author's patients with a certain amount of arteriosclerosis, turning back of the sclerotic carotid artery is almost impossible, if not entirely so. The first successful union of two arteries in a human, by Murphy,<sup>29</sup> was by an invagination method.

Later workers with this method have introduced various sorts of rings made of ivory,<sup>30</sup> of pigeon bone,<sup>35</sup> of magnesium,<sup>21,31</sup> of Vitallium<sup>8</sup> or of silver or other substances to assist in the turning back process. Since such a ring is usually left in the wound as part of the anastomosis, its material may be chosen either for inertness, as with Vitallium, or for absorbability as with magnesium.

Removable rings of various types have also been used which are generally supplied with handles; these may be removed as soon as suturing of the vessels is completed.

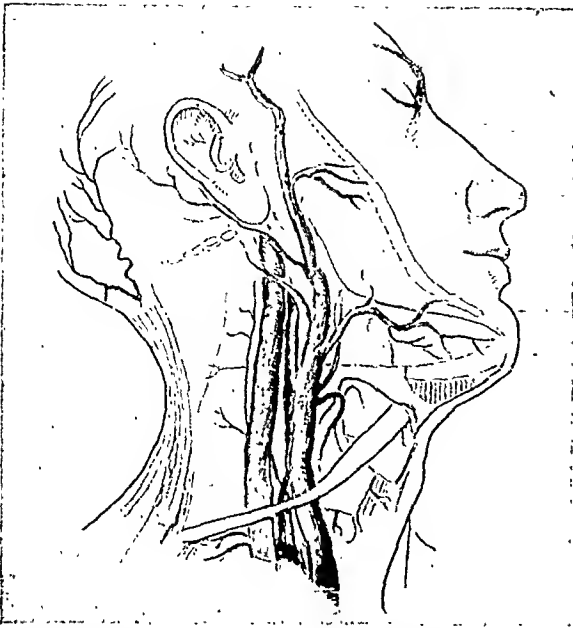


FIG. 1. Diagram of right side of neck before operation showing carotid artery (to right) and internal jugular vein (to left).

Among such are the Crile cannula and the Elsberg monkey wrench cannula.<sup>7</sup> These were popular when temporary arteriovenous anastomoses were used between two persons for blood transfusions and are less suitable for permanent anastomoses.

The internal jugular vein when severed and devoid of blood is difficult to control because of the thinness of its walls. The writer has not yet used a Vitallium tube, a Crile cannula or a similar device with human patients but believes that such might facilitate handling of the vein. After the operation is completed, however, the tube or cannula would not be left as part of the anastomosis. It would necessarily be removed since it would have been used to support the larger vessel rather than the smaller one.

**Operative Procedure.** The patient is prepared in the normal manner and under local anesthesia. An incision is made along the anterior border of the sterno-cleido-mastoideus muscle through the integuments, superficial and deep fascia. The internal jugular vein and common carotid artery are dissected free of fascia, care being taken to avoid undue irritation of

the vagus nerve or of the carotid sinus. The vagus nerve is carefully pushed aside. (Fig. 1.)

All communicating branches of the internal jugular vein are doubly ligated close to the vein and severed. There are generally two of these but sometimes one or three. There is a large communicating vein between the external jugular and internal jugular veins. The author has doubly ligated this vein as part of the operation, except that in one or two cases with blood pressures around 240 mm. it seemed best to leave this as an anastomosis to relieve the excessive blood pressure. The common carotid artery has no branches until it bifurcates into the internal and external carotid arteries at the carotid sinus. This usually takes place at the upper border of the thyroid cartilage.

At this stage of the operation the common carotid artery is now stretched very gently until it is fairly loose and has a tendency to be longer than necessary. This is a very important step without which serious accident may occur. Previous workers have often begun to make a double arteriovenous anastomosis and had to be content with a single anastomosis, perhaps with transplantation of a portion of vein to fill a gap; proper stretching of the artery will avoid such embarrassments.

The clamps are then placed on the common carotid artery and on the internal jugular vein and the vessels are severed. An end-to-end anastomosis is effected first between the cardiac part of the carotid artery and the cephalic part of the internal jugular vein. Then a separate anastomosis is effected between the cardiac part of the internal jugular vein and the cephalic part of the common carotid artery. To avoid tedious repetition in description of the cases to follow and in other parts of the paper this operation is referred to simply as a double arteriovenous anastomosis, that is, it is so defined for the purposes of this paper. After the anastomoses are effected the clamps are released slowly and on the vein first; all

leaks are repaired before full arterial pressure is admitted.

The writer's technic for the anastomosis has been worked out by him on dogs. The animals recover well after the double

The needles are then forced through the vein from within outward in the proper symmetrical positions and the artery is inserted into the vein. The sutures are simultaneously pulled tightly and then

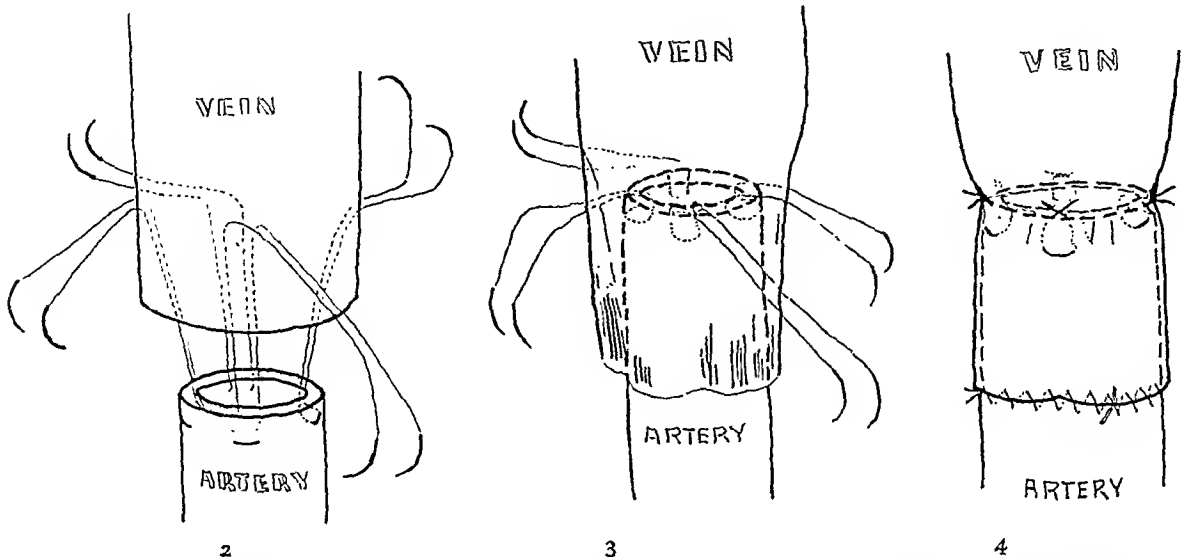


FIG. 2. General arrangement of four preliminary sutures. This much is somewhat similar to the arrangement used by Murphy<sup>29</sup> except that he used three sutures (six needles) and also started from *inside* the artery instead of from outside. Also he joined two arterial stumps. It may be desirable to use more spacing between the ends of a suture, in the vein, than shown above.

FIG. 3. Four preliminary sutures after drawing or inserting artery into vein. Since the vein is quite flexible, there is very little suture material in contact with flowing blood in the final anastomosis.

FIG. 4. Final anastomosis. Preliminary sutures have been tied, additional sutures placed on the sleeve of the vein to tack it to the artery and further sutures added wherever needed to repair leaks or to strengthen the anastomosis.

anastomosis or double reversal of circulation has been performed on both sides of the neck.

The internal jugular veins of the human being are much larger than the common carotid arteries. In the dog the difference is not so great. The technic used can be easily understood if reference is made to the illustrations. (Figs. 2 to 4.) After the artery is severed a mattress suture is placed in the artery from without inward, using a double-needle suture. The needles are brought out through the opening or lumen of the artery as close as possible to the cut edge of the arterial endothelium. This is to give as much strength as possible to the suture without undue exposure of suture material to blood flow in the finished anastomosis.

Four such sutures (with eight needles) are placed in the artery symmetrically.

tied. The posterior one is tied first, otherwise it would be hard to reach.

Next, a continuous suture is placed on the sleeve or cut end of the vein, including the arterial wall except for its endothelium. This gives a sort of double set of sutures. This seems important in the junction of such large vessels. Upon removal of the clamps any leakage is controlled by further suture and pressure. The wound is then closed by suturing all anatomic layers as is usual in neck surgery. (Fig. 5.)

An immediately apparent effect after the operation is that the patient becomes cyanotic to a greater or lesser degree for a few hours to a few days. Then the cyanosis gradually clears. The cyanosis, however, occurs only in the face and not the body, being due to disturbance and interruption of the normal flow of blood to and from the head. Hence, the normal oxygen and

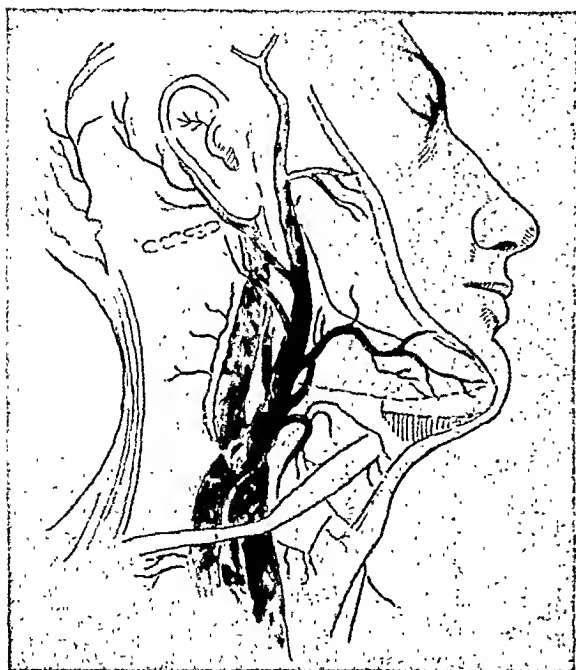


FIG. 5. Diagram of right side of neck showing carotid artery and internal jugular vein after double arteriovenous anastomosis.

carbon dioxide balances of the blood to the brain are disturbed. Since increased blood carbon dioxide causes dilatation to vessels of the brain and since greater flow of blood through the brain is necessary for the relief of ischemic conditions, these cyanotic effects are perhaps desirable.

The patient complains of some headache and pain following operation but the inconvenience is surprisingly little. There is some apprehension and the patient complains of some pounding in the ears. A definite bruit is audible for some weeks over the internal jugular vein at the point where the arterial blood enters it. Some patients can hear this sound for at least some weeks after the operation, even after the pounding in the ears has ceased.

The objective symptoms include cyanosis at first, followed by clearing of this condition, and also a marked drop in systolic blood pressure. It may be noted that the operated patients were usually hypertensive and there was a definite lowering of the systolic blood pressure which remained lowered.

## CASE REPORTS

**CASE 1.** I. D., aged fifty-six, was admitted to St. Agnes Hospital on April 20, 1944, with the following history: She stated that following a dizzy spell on November 11, 1943, she suddenly became unable to lift her left arm. The following day she became completely paralyzed on the left side of her body. Her physician stated that although she was treated both at home and in a hospital, there had been no noticeable improvement.

The author found a heavy set, middle-aged woman with a blood pressure of 210/110 and complete paralysis of the left side, with inability to move either her left arm or her left foot. There was chronic left sinusitis with thickened membrane and a trace of albumin in the urine as well as some pus.

On April 21, 1944, under local anesthesia, a right double arteriovenous anastomosis was made between the common carotid artery and the internal jugular vein of the right side. The patient returned to her room in good condition, although with slight cyanosis of the face, and was kept well narcotized for twenty-four hours. On April 23rd the blood pressure was down to 150/95, the cyanosis appeared cleared and the patient felt fairly well although she had some pain in the left side of her head. On April 25th the patient complained quite severely of pain in the right eye, although a fundus examination revealed no disorder. By April 28th the pain in both the right eye and the left side of her head had disappeared. The transient pain in the right eye may have been related to "pulsating exophthalmos," a possibility previously discussed.

On May 2nd she appeared bright and cheerful and all stitches were removed. On May 4th she moved her left leg for the first time in six months and was able to do so at will. On May 8th she was dismissed from the hospital; two weeks later she was able to get out of bed under her own power. In 1946, she was able to get around her house and do light housework. Her left leg and arm were spastic but usable; she was able to get around with the aid of one crutch. Her blood pressure still remained around 150 systolic. At the present time this patient is feeling very well, has gained considerable weight and is able to get around the house. She still wears a brace on her left ankle for support and uses a crutch whenever she has to be on her feet for any length of time. Blood



pressure is now 160/100. There has been no further improvement of the arm and very little if any of the leg since the last report.

CASE II. O. D., aged sixty-one, was admitted to St. Agnes Hospital on July 25, 1945, with the following history: She had been given shock treatment by another physician for correction of a mental disease. Following treatment, she became completely paralyzed on the right side and lost her speech. Her physical condition was average; blood pressure was 165/80. She refused to eat and had to be fed by a stomach tube.

On August 4th under local anesthesia, a left double arteriovenous anastomosis was made between the common carotid artery and the internal jugular vein of the left side. The patient returned to her room in good condition, except for some cyanosis of the face. She was kept well narcotized for twenty-four hours, after which the cyanosis cleared. On August 6th her blood pressure was down to 130/90. On August 16th the sutures were removed but the mental condition seemed unimproved, and she could not speak. By August 25th the patient responded to questions better by shaking or nodding her head. Also on this date she was, for the first time since the shock treatment, able to take food by herself instead of with aid of a stomach tube. Improvement continued to September 4th, at which time her blood pressure was 150/90.

On September 5th operation was performed. The patient stood the operation well although cyanosis again developed; she returned to her room in good condition. Three hours later obstructive breathing occurred. The patient expired, autopsy was refused and the cause of death was not known. From the nurse's report it appeared that there may have been acute edema of the larynx.

CASE III. W. B., aged sixty-four, was admitted to St. Agnes Hospital November 30, 1944, with the following history as told by relatives: On September 25, 1944, he became suddenly ill and lost his speech. Later that evening he became paralyzed on the right side. Although treated both at home and in the hospital, there had been no noticeable improvement. The author found a man of small stature who appeared to be older than the age stated. He presented tortuous blood vessels in the temple and in the bend of the elbow. All the vessels appeared sclerotic; the blood pressure

was 188/100. The right half of the body appeared to be completely paralyzed.

On December 2, 1944, under local anesthesia, a left double arteriovenous anastomosis was made between the common carotid artery and the internal jugular vein of the left side. The artery was extremely sclerotic; one-half of the lumen was occluded to give a typical pipestem vessel. After operation the patient appeared to be in good condition except for cyanosis of the face which continued for about three days. The patient returned home on January 2, 1945. His speech and ability to move his paralyzed limbs had not improved. However, he seemed to respond better to questions than before operation. While before operation he had to be fed by mouth, he now took nourishment by himself and was apparently feeling much better.

Both before and after operation the patient suffered from severe uremic conditions. This patient expired five months after operation. The cause of death was unknown, as the patient had left the vicinity.

CASE IV. R. C., aged fifteen, was admitted to St. Agnes Hospital on October 30, 1946, with the following history according to his mother: His early childhood was not remarkable; he had chicken pox and measles. Epileptic seizures began at five years of age of a very light, static staring type which lasted generally only a few seconds. They continued to be mild, although with some increasing severity, until he fell 18 feet from a tree in June, 1943. He was unconscious twenty-four hours and hospitalized five days. The seizures then became more severe, often with unconsciousness for many minutes, that is, he would not remember afterward what happened during the seizures. If walking when a seizure appeared, he might fall to the ground with a typical grand mal.

Beginning in June, 1943 and until October 31, 1946, he might have from five to seven epileptic seizures daily, with typical tonic and clonic convulsions lasting from a few seconds to twenty minutes. About three times weekly he had a typical grand mal seizure.

In addition, during the three-year period, he had eight or ten spells in which he would go into a semicomatose condition lasting from one-half hour to three days, the longest spell being about two and one-half years ago. During these spells he could walk around but did not



know where he was or what he was doing. There were no convulsions during these spells but each was always followed after a day or so by a very severe epileptic seizure.

Beginning at five years of age, treatment was given with  $\frac{1}{2}$  gr. doses of phenobarbital three times daily, but seizures still gradually increased in intensity and frequency although they would be less frequent during actual phenobarbital dosage. Following the fall, phenobarbital in  $1\frac{1}{2}$  gr. doses three times daily, later three daily doses each of  $1\frac{1}{2}$  gr. dilantin daily and still later three daily doses each of 5 gr. tridione, seemed of little help. Treatment in various clinics and hospitals was tried without apparent result.

From October 15, 1946 to November 1, 1946, he took each day:  $1\frac{1}{2}$  gr. phenobarbital, three  $1\frac{1}{2}$  gr. dilantin capsules and three 5 gr. tridione capsules daily. In spite of this he had a very severe epileptic seizure on October 30, 1946.

When first seen by the author on October 31, 1946, thorough physical examination revealed little abnormal, except that all reflexes were apparently exaggerated. Blood pressure was 140/85 and the red count was 4,750,000 per cu. mm.

On November 1, 1946, a right double arteriovenous anastomosis of the common carotid artery and internal jugular vein of the right side was performed. Immediately following operation there was slight cyanosis of the face which lasted only a few hours. The patient stood the operation well and was kept well narcotized for four days. Barbiturates were then gradually reduced and were stopped altogether on November 11, 1946. Two days later the patient returned home.

Shortly thereafter he had a rather severe epileptic convulsion although not as severe as previous to operation. He is now taking three  $1\frac{1}{2}$  gr. capsules of dilantin daily. Immediately following the operation, blood pressure dropped to 120 systolic and has remained there.

Daily reports from his mother indicate that, so far, there appears to be marked improvement. Instead of several seizures daily there are now about three weekly. Also, the boy states that since the operation, he does not become completely unconscious during a seizure, that is, afterward he is able to recall what others were doing during the seizure. During the week December 1 to 7, 1946, two of the

three seizures were mild and hardly noticeable. The third, while more severe, did not cause unconsciousness.

About December 1, 1946, the boy was able to return to school; he had been unable to attend school except for one month during the past years (1946) because of the epileptic attacks. This young man at the time of operation was fifteen years of age, his weight was 147 pounds and height was 5 feet  $11\frac{1}{2}$  inches. At the present time he is sixteen years of age, weighs 175 pounds and is 6 feet 3 inches tall. He has been attending school regularly since December, 1946, takes part in physical education activities and has discontinued taking any kind of medicine.

Seizures, which occur occasionally, are much lighter; he does not fall or become unconscious. Intervals between seizures have been as long as thirty days.

About May, 1947, there was a noticeable dilatation of the anterior facial vein. This dilatation became progressively worse and more noticeable until July, 1947, at which time he was reoperated upon with ligation of the common facial vein. The patient left the hospital on the fourth day. This condition was completely cured.

#### COMMENTS

Cases II and III showed the least improvement, a fact that was first ascribed to the patients' greater age and generally poorer condition at time of operation. In particular, the patient described in Case III had arteries so hardened and thickened that operation was rather difficult. Nevertheless, it is true that these patients were operated upon on the left side while the best cases, I and IV, were operated upon on the right side. Thus, it may well be that the right side should be the choice for operation.

As already remarked, operation on this side presents greater technical difficulty because of the shortness and other anatomic features of the right common carotid artery. Discussion of the anatomic phase showed that arterial blood introduced into the right internal jugular vein should find its way into the superior sagittal sinus. Thus, the veins supplied with

arterial blood should be the ones that are observed in skull-window experiments rather than the deeper veins. The highly successful double anastomosis of Guthrie in a dog<sup>16</sup> was on the right side.

Furthermore, the report of Andreyev<sup>2</sup> on dogs with the two carotid and two vertebral arteries ligated indicates that after all it may be the surface region of the brain hemispheres that is first to lose its blood supply. Thus, in an injection autopsy of such a dog:<sup>2</sup> "The arteries on the convex surface of the hemispheres did not contain any of the opaque substance." This would be the general region that could be supplied with arterial blood through the right jugular vein. Because of the limited number of cases presented here, however, further speculation on choice of right or left side for the operation is deferred.

The fall in blood pressure after operation, which was from 210 to 150 systolic in Case I, is immediate and dramatic. While high blood pressure in some patients is believed to arise from kidney dysfunction, it may also be postulated that if there is a region of the brain with circulatory deficiency, the blood pressure may rise in an effort to restore the blood flow in that region. Support for this hypothesis is found in a statement by Alvarez:<sup>1</sup> "When with a suspicious episode a high blood pressure drops to normal I look on this happening as strongly supportive of the view that there was a small stroke, because I have seen this happen so many times." In his case VII, for example,<sup>1</sup> following one of her "spells," blood pressure dropped immediately from 200 to 135 systolic and remained there. In this patient it is likely that there had been circulatory difficulty in a region of the brain but that a sudden cerebral accident destroyed the circulation so completely that further attempts by the heart to maintain circulation there were useless, hence the blood pressure dropped to normal. It is postulated that in the author's cases when nutrition of ischemic areas was restored by circulation reversal, the need for high blood pressure may

similarly disappear, although by restoration rather than by destruction of the ischemic region. But with either the type of "small stroke" described by Alvarez or with circulation reversal, there being sometimes no further need for the high blood pressure, it can fall to normal.

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# DEVELOPMENT OF ULTRAVIOLET BLOOD IRRADIATION

E. K. KNOTT, D.Sc.

*Seattle, Washington*

THE development of ultraviolet blood irradiation therapy was an outgrowth of an attempt to utilize the bactericidal properties of ultraviolet rays in the treatment of blood stream infections. If the greatest advantage was to be derived from the bactericidal properties of the rays, a method of applying them directly to the blood stream of the patient had to be developed. The problem faced was twofold in nature: (1) to develop a method of application and (2) to determine the necessary dosage.

The first step taken was to review the literature on ultraviolet irradiation in general to determine what, if anything, had been accomplished along this line and the extent of success or failure. The literature, mostly from European sources, was voluminous and seemed to establish the fact that some researchers in the field believed that most of the systemic reactions observed following exposure of the skin to ultraviolet rays were due to the influence of the rays upon the blood.

It was noted in the literature that the source of the ultraviolet energy was inconstant and varied widely. This fact alone would produce variable results and often a failure to obtain any measurable results. A source of ultraviolet of known intensity was sought that could be easily controlled so that a uniform dosage could be achieved and duplicated at will. The Burdick water-cooled ultraviolet generator was selected as having the desired characteristics.

It was believed that a method of exposing the blood directly was feasible. An irradiation chamber was developed by Knott and Edblom to allow direct exposure of the blood. The irradiation chamber was circular and approximately 2 inches in diameter and about 1 inch thick. The

inside of the chamber had a labyrinthian passage connecting the inlet and outlet formed by baffle plates that were ground to fit flush against the quartz window that formed the top of the chamber. Thus the blood must flow through the labyrinth by passing around one end of each baffle plate instead of across them. The labyrinth was approximately 1 cm. deep.

The irradiation chamber was so designed as to provide maximum turbulence of the blood to accomplish two desired effects: (1) to prevent the formation of a film of blood forming on the chamber window that would absorb and filter out much of the desired wave lengths of ultraviolet. In an opaque substance, such as blood, it is necessary to turbulate the substance to prevent the formation of a film of blood that absorbs the ultraviolet and prevents it from reaching the flowing substance. (2) To insure that all parts of the blood be equally exposed to prevent overexposure of some parts and underexposure of others. If the blood flowing through the chamber is not turbulated, a portion of it remains next to the window and absorbs the ultraviolet thus preventing uniform exposure of the total volume and resulting in the overexposure of one portion and underexposure of others. The development of the irradiation chamber provided a method of exposing blood uniformly so that all parts were equally exposed and that a uniform and repeatable dosage could be administered.

The first step taken in the original work by Knott and Edblom was to determine roughly the tolerance of the red blood cells to ultraviolet rays when directly exposed in whole blood. Small quantities of whole blood were placed in a quartz test tube and citrated 1 to 5 with a 2½ per cent solution of sodium citrate. With

the ultraviolet generator operating at 60 volts and 4+ amperes supplying wave lengths 2399 to 3650-54 Angstrom units, the blood samples were exposed at contact with the source of ultraviolet from 0 to 280 seconds in five-second and ten-second graduations of exposure. After each interval the specimens were microscopically examined to note any change in the form of the red blood cells. No change was noted up to seventy seconds and then a slight poikilocytosis occurred. This condition disappeared after eighty seconds and no further change was noted up to 280 seconds when disintegration took place.

This same procedure was followed with whole citrated blood inoculated with cultures of *Staphylococcus aureus*. Cultures were taken after each interval. Growth of the organisms occurred only in the first three samples with no growth showing in any sample exposed more than ten seconds. These experiments were repeated until it was demonstrated that the bactericidal properties of the rays were effective well within the tolerance range of the red cells.

The next step was to undertake animal experiments. Strains of *Staphylococcus aureus* and hemolytic streptococcus of known virulence to dogs were used. These organisms were injected in gross amounts intravenously into dogs and cultures taken periodically to insure that acute septicemia developed. The animals were then irradiated by tapping two veins and pumping the blood from one to the other through the irradiation chamber. The pumping was accomplished with a Luer syringe and a three-way valve. The process was continued until the estimated total volume of the animal's blood had been irradiated. As the blood passed through the irradiation chamber, it was subjected to ultraviolet irradiation from a Burdick water-cooled ultraviolet generator held in contact with the chamber, the actual source of the ultraviolet being approximately 3 cm. from the chamber window. The test animals all died on the fifth to seventh day from what appeared to be a

combination of profound depression, a progressive respiratory slow-up and failure. All the animals at the time of death had negative blood cultures, thus indicating that the organisms had been destroyed, a marked contrast to the control animals in whom death was preceded by an overwhelming septicemia. The literature suggested that overexposure to ultraviolet rays could conceivably produce a profound depressive effect.

It was then attempted to determine the susceptibility or tolerance of the host to ultraviolet rays impinged directly upon the blood stream. This was approached by two methods: (1) To irradiate the entire blood stream, but with reduced dosages to determine the maximum the animal could stand, and (2) to maintain the dosage of the earlier experiment and to reduce the total volume irradiated.

The latter method had been suggested by an incident in which the apparatus had failed and only partial irradiation had been accomplished; the test animal in this instance survived and negative blood cultures were achieved. Both methods were pursued until it was established that the second method was subject to less mechanical difficulty and productive of more uniform results.

From these experiments it was found that it was unnecessary to expose the blood sufficiently to kill the bacteria directly. It was also noted that it evidently was unnecessary to expose all of the blood to achieve a desired effect upon the entire blood stream. The total amount of blood to be irradiated was determined to be  $\frac{1}{16}$  to  $\frac{1}{20}$  of the estimated blood volume or approximately  $1\frac{1}{2}$  cc. per pound of body weight. Continued work, using the same virulent bacteria, established the fact that ten test animals treated by the newer system, all recovered from an overwhelming infection and that none showed any ill effects. All dogs were carefully checked with blood counts and continued observation; no untoward results were noted after four months in most of the animals, and

after four years in the case of one to which we became attached sentimentally. Four untreated dogs died of septicemia.

From observations made on the work done on animals a corrected or extended hypothesis was established. The evidence accumulated so far seemed to indicate that the impingement of small, carefully regulated doses of selected ultraviolet rays directly upon the blood stream of test animals in some way increased the bactericidal properties of the blood stream; that by this method of treatment some influence was exerted upon the vital resistance factors of the host, enabling it to overcome the infection and to progress to complete recovery; that some influence was exerted upon the toxic conditions produced by the disease, either by direct action upon the toxins themselves or by indirect action on the toxins through the host's rallied defense mechanisms. To what extent any of the above is true or false was not determined from the data available from the work done to this point. The literature searched earlier indicated that certain known toxins had been inactivated directly by ultraviolet rays under given conditions, but whether and to what extent it was possible to vary the conditions and still produce the result was not known, nor was it known whether such a detoxification effect could be produced *in vivo* as well as *in vitro*. The work on animals was carried on until it was definitely determined that the animals suffered no ill effects from the treatment and yet showed a clinical detoxification *in vivo*.

The first treatment on a human took place in 1928. Consultation held the patient to be in a moribund state from septic abortion complicated by hemolytic streptococcus septicemia. Ultraviolet blood irradiation therapy was instituted as a last resort to see if the septicemia in a human could be affected. The patient responded to treatment and proceeded to an uneventful recovery. She has since borne two children, and when last checked in 1940 was found to be in good health

with a normal urinalysis and blood count. Nothing further was done in the treatment of human patients until 1933.

In the meanwhile some work was done in Chicago at a private research foundation where experiments were conducted to try to determine what particular component of the blood was most profoundly affected by ultraviolet irradiation and in what manner. This work had to be curtailed without definite results being obtained because of the difficulty of following the chain chemical reactions set up and the lack of equipment and money to pursue them to conclusion. To the author's knowledge, technics have not as yet been devised to determine the end result or the *modus operandi* of chain chemical reactions set up by the stimuli of ultraviolet rays to such a complex compound as human blood. No conclusions were drawn as to the results obtained in Chicago. Clinical observations seemed to us to be the most important procedure to follow next until sufficient knowledge could be accumulated from the use of the procedure upon which to base problems of basic research.

This first became possible in 1933. Virgil K. Hancock, M.D., of Seattle, Washington, with James Tate Mason, M.D., a consultant, felt justified in using the procedure as a last resort on a patient, apparently moribund, with advanced hemolytic streptococcus septicemia. This case was described in detail by Hancock and Knott<sup>1</sup> in the first published article reporting this technic. Successful conclusion of the case led to further use in similar cases of serious nature in which it was believed the patient was in a moribund state.

In this work with Hancock, daily blood counts and cultures were taken on all patients treated. Careful study of these blood counts revealed that in cases of overwhelming infection, when leukopenia was present, there was following ultraviolet blood irradiation a rise in the white cell count to a degree consistent with the severity of the infection, the count then

diminishing with clinical improvement. An increase was also noted in the red cell count in patients suffering from hemolytic streptococcus septicemia. Consistent responses were achieved in the treatment of septicemia, but it was noted that streptococcus blood stream infections were more easily controlled than were staphylococcus, the latter requiring usually more than one treatment, while the former usually responded favorably to one. In a large majority of the cases, a marked cyanosis was present at the time of initiation of ultraviolet blood irradiation. It was noted that during the treatment or immediately following the treatment a very rapid relief of the cyanosis occurred with a corresponding easement of respiratory embarrassment. This response was consistent and was, in a majority of cases, accompanied by a noticeable flushing or reddening of the skin with a distinct loss of pallor. It was not determined at first whether this phenomenon was due to a greater assimilation of oxygen or a vasodilation effect, or both.

The easing of respiratory embarrassment that occurred consistently in septicemia led to the application of the procedure in cases of well defined and well diagnosed pneumonia. In a series of seventy-five cases in which the diagnoses were confirmed by x-rays, all patients were treated by this method and, according to Hancock, the method was found to be extremely valuable in combatting the pneumonia. The course of the disease following ultraviolet blood irradiation was marked by a rapid fall in temperature, disappearance of cyanosis, often within three to five minutes, cessation of delirium if present, a rapid subsidence of toxic symptoms generally, a marked reduction in pulse rate and a rapid resolution of consolidation. A shortening of hospitalization and convalescence occurred regularly. This procedure was later found by Miley to be especially valuable in the treatment of virus type pneumonia in which chemotherapy had proven of doubtful value.

The consistent results obtained in treatment of cases of septicemia gave rise to the question as to the *modus operandi* of irradiated blood. In an endeavor to find out the process of sterilization of the blood stream, opsonic index studies were made to see if the phagocytic power of the polymorphonuclears was influenced by ultraviolet blood irradiation. These studies were started in 1936. When proper exposure *in vitro* had been determined, it was noted that the average increase in the bacterial ingestion by polymorphonuclears was 50 per cent plus. This work was repeated in 1946 with improved technic and the ingestion of bacteria by polymorphonuclears was found to be increased up to 78 per cent. It was also determined that there was very little latitude between the proper exposure at which the polymorphonuclears were stimulated to a maximum degree of ingestion and the amount of exposure at which they were destroyed. Destruction of the polymorphonuclears was characterized by a blowing out of the surface of the cells. Although bacteria were present within the cell, the cell was destroyed on one surface. It was not determined just how this destruction took place but it is significant that when the proper exposure was exceeded by 25 to 40 per cent such destruction consistently took place. The general literature on the subject cites examples of this phenomenon on cells from overexposure.

From the information up to this point and considering the clinical experiments, personal experience and observation, the technic was improved, and this improved technic is known as the "Knott Technic of Ultraviolet Blood Irradiation." The irradiation chamber was also redesigned to give a more thoroughly uniform exposure to the blood and became the Knott Hemo-Irradiation Chamber now in use.

A number of irradiation units were made up and placed in the hands of physicians interested in the procedure so that wide clinical data could be accumulated. It is noteworthy that none of the physicians



using the procedure in different parts of the country found any cause from their observations to disagree with the early hypothesis that had been set up to govern its use. It is also significant that all the physicians using the procedure enjoyed parallel results in like conditions as long as the prescribed technic was strictly adhered to. It was determined from the work done that the established technic was not subject to variation. While the technic was simple, it had to be adhered to strictly. Any variation at all would produce variable results. Investigations that led to the development of the established technic revealed that exposure factors have to be varied as the media exposed are changed, i.e., whole blood requires different handling than does plasma. The depth of the channel in the exposure chamber is a critical factor. Exposures of culture media for the production of vaccines necessitates a different chamber construction and a corresponding change in the time factor to achieve the desired results. The established Knott technic of ultraviolet blood irradiation therapy was worked out for the exposure of whole blood and was arrived at by correlating all of the factors of energy, time cell tolerance and turbulation of the blood. In all media being irradiated it was noted, as set forth in the literature, that intermittent exposure required less total exposure time than a continuous exposure to produce the same end result. Intermittent exposure also facilitates a more uniform dosage being administered.

Dr. George P. Miley, of New York, was one of the early workers with the procedure after Knott improved the chamber and released them to physicians for further accumulation of clinical data. Miley became interested in the oxygen exchange factor, suspected and commented upon by Knott. He was particularly impressed by the rapid disappearance of cyanosis following treatment. Miley made extensive studies on the combined oxygen values of venous blood before and after

irradiation in pathologic states. This work<sup>2</sup> was published in June, 1939, and showed a general increase in the combined oxygen value of venous blood following irradiation.

Another early worker, Dr. E. W. Rebeck, and his co-worker, Glassburn, of the Shadyside Hospital in Pittsburgh, became interested in the relief of toxic symptoms following treatment and surmised that if such was the case, it should be reflected in the lipoidal fraction of the blood and show a change in the chylomicron picture. They made interesting observations in the chylomicron study of about 100 patients. They observed that in advanced pathologic states the clumping of the blood fats was restored to a normal state, both *in vivo* and *in vitro* immediately following the exposure of the blood to the Knott technic, i.e., they noted the dispersal and breaking up of the blood fat clumps present in a toxic patients' blood, plus a return to normal of the lost Brownian movement of lipid particles, the fats indicating a return to normal of the whole chylomicron picture. As the Brownian movement of the blood fats return, there is often but not always a return to normal of the blood sedimentation rate and a decrease of the toxic symptoms. This latter result is most consistent and is noticeable within twenty-four to forty-eight hours following treatment. Usually a marked drop of temperature to normal is evidenced concomitantly.

The procedure has been used clinically and reported upon by several workers following Hancock and Knott's<sup>1</sup> article on the treatment of infections with the method. Barrett<sup>3,4</sup> discusses five years' experience and reported on irradiation of blood with ultraviolet spectral energy in two articles. Miley<sup>2,5-14</sup> published articles on the use of the procedure in the treatment of thrombophlebitis,<sup>5</sup> staphylococcemias,<sup>6,9</sup> botulism,<sup>7</sup> poliomyelitis,<sup>8</sup> non-healing wound,<sup>10</sup> acute pyogenic infection,<sup>11,14</sup> and Miley and co-workers have reported its use in peritonitis,<sup>15</sup> acute infections<sup>16</sup> and asthma.<sup>17,18</sup>



In 1947 Miley reported the use of this method in seventy-nine consecutive cases of acute virus and virus-like infections, stating that he believed ultraviolet blood irradiation therapy could be relied upon consistently to control an infection of a virus or virus-like nature in a safe and efficient manner. In discussing this paper Barger gave a report of twenty-three cases of bulbar poliomyelitis and six cases of spinal poliomyelitis in which he definitely believed he could confirm Miley's observations. In addition Barger quoted in detail three cases of advanced encephalitis in which he had used ultraviolet blood irradiation, stating that in each case following this type of treatment a rapid disappearance of all signs and symptoms of encephalitis occurred, and that no residuals were apparent after from six months to three years.

Rebbeck has reported its use in *Escherichia coli* septicemia,<sup>21</sup> postabortal sepsis,<sup>22</sup> puerperal sepsis,<sup>23</sup> and its use preoperatively,<sup>20</sup> and Rebbeck and co-workers reported on peritonitis<sup>15</sup> and double septicemia.<sup>19</sup> Rebbeck and Lewis<sup>30</sup> have found in nine consecutive cases of typhoid fever that in six patients who received ultraviolet blood irradiation there was a remarkably rapid recovery as contrasted with three control cases in which one death occurred.

Olney has reported on the treatment of pelvic cellulitis<sup>24</sup> and biliary disease<sup>25</sup> with ultraviolet blood irradiation. Hancock<sup>26</sup> discusses its use in blood stream infections. Davidson<sup>27</sup> further discusses oxygen reaction in anoxia and bends. Sullivan and Beroza<sup>28</sup> discuss short time irradiation on biochemical compounds and the influence on phagocytosis.

From the published reports of the clinical use of the procedure evidence has been accumulated upon which to found further basic research and investigation.

Up to 1940 the administration of ultraviolet blood irradiation had been carried on by a gravity and manual method of flow and timing. Such a method of applica-

tion, of course, left a margin for human error, as the operator had to observe the rate of flow and time exposure as well as other factors in the irradiation treatment. To eliminate this margin of error, an apparatus was designed to control mechanically all the factors of irradiation and insure dosage that could be repeated at will. This apparatus now known as the Knott Hemo-Irradiator was first displayed at the Scientific Exhibit Section of the American Medical Association's meeting in New York in 1940.

The apparatus consists of a self-contained, water-cooled, ultraviolet generator and an electrically driven transfusion pump and exposure device that mechanically controls the rate of flow and exposure of the blood to the rays. The apparatus can be accurately controlled as to the amount of ultraviolet generated as well as the time of exposure of the blood to the ultraviolet ray. Between the source of the ultraviolet rays and the blood irradiation chamber there is a revolving shutter that subjects the blood to intermittent exposure to the rays. The turbulence within the chamber augmented by the pump causes the blood to turbulate against the quartz window of the chamber so that a uniform exposure of all parts of the blood is insured.

Since development of the Knott Hemo-Irradiator, clinical application of the procedure has greatly increased. Since 1923, when ultraviolet irradiation of the blood was first conceived, approximately 45,000 treatments have been administered in various pathologic conditions. The field of use has widened materially from the original application of the procedure in the treatment of blood stream infections, as experience and research indicated that it would be adaptable to pathologic conditions other than blood stream infections. As a result of extensive clinical experience and a certain amount of basic research, workers in this field are generally agreed that the favorable clinical results observed are due to many biochemical and physio-

logic effects: notably an increase in blood oxygen absorption, a rise in phagocytic action and general immunologic status, the setting up of an efficient detoxifying mechanism, and increased rate and volume of blood flow through the capillary circulation and beneficial alteration chemically of certain important constituents of the blood, e.g., adrenalin, dihydroxy-phenylalanine, cysteine hydrochloride, glutathione and ergosterol.

Thus ultraviolet blood irradiation therapy must be considered as a powerful therapeutic agent which the skilled physician and surgeon can use in a wide variety of disease processes, since in using this method one is applying certain fundamental biochemical and physiologic effects.

The favorable results experienced from the clinical use of the ultraviolet blood irradiation certainly warrants extensive investigation of the *modus operandi* of the procedure and detailed, intensive clinical studies to determine fully its potentialities.

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## GASTRIC DIVERTICULA\*

MELVIN A. CASBERG, M.D.  
Diplomate, American Board of Surgery

AND WALTER P. MARTIN, M.D.  
Diplomate, American Board of Internal Medicine  
*Long Beach, California*

A REVIEW of the available medical literature impresses one with the apparent infrequency of gastric diverticula, in fact, most articles on this subject refer in their opening paragraphs to the rarity of such an abnormality and the lack of clinical and pathologic experience with this specific condition. However, with the rapid improvement in roentgenologic technic, an ever increasing number of reported cases are accumulating, most of which have appeared in publications during the past twenty-five years. The paucity of reports prior to this period can be explained on the basis of the fact that it is almost impossible to make a preoperative diagnosis of a gastric diverticulum without the aid of x-ray study.

It appears to be the consensus of medical opinion that a fairly high percentage of such diverticula are asymptomatic and are discovered quite by accident during routine surgical, postmortem or roentgen-ray examination. Furthermore, the surgeon who has had operative experience with this condition will concede that many gastric diverticula are overlooked in the operating room as well as in the postmortem room. An out-pouching of the stomach that appears quite obvious when filled with barium has the facility of remarkable contraction when empty. One may safely assume that all proven cases of diverticula of the stomach have not been reported, perhaps among other reasons because they are considered by some to be of little clinical significance.

Granted that this abnormality is uncommon it still appears that it is not as rare as the literature would lead us to believe. Unfortunately, insufficient data

has been accumulated to permit a thorough evaluation of the diverticulum in reference to gastric symptomatology and therapy. In the interests of further clarifying the issue this paper is presented. Two new case reports are included with surgical verification of their preoperative diagnoses.

Fournier<sup>1</sup> in 1774 is credited with first describing gastric diverticula as a pathologic entity and Helmont,<sup>2,3</sup> in 1804 is said to have reported the first case of such an abnormality. Martin<sup>4</sup> in his extensive study of the historical background of this subject refutes these statements as false and adds the correction that Thomas Baillie in 1793 reported the earliest authentic case. Brown<sup>5</sup> first demonstrated by x-ray a gastric diverticulum preoperatively in 1916; however, he misdiagnosed the findings to be those of an ulcer. Akerlund<sup>6</sup> in 1923 gave great impetus to the interest in this condition when he published a monograph on the roentgenologic aspect of diverticula of the stomach.

By 1923 Tupper<sup>7</sup> found thirty-eight cases reported in the literature and a little more than a decade later Rivers, Stevens and Kirklin<sup>3</sup> presented fourteen proven cases which they added to the 141 cases mentioned in their report. One year later Martin<sup>4</sup> wrote that "an exhaustive search through the Archives of the History Department of the Johns Hopkins Hospital was unfruitful in revealing a single case diagnosed ante mortem. Not one was reported after laparotomy. Apparently none was reported by the roentgenologic department. The search was continued through the records of the pathology department and five cases were found."

Tracey<sup>8</sup> in 1943 reviewed the cases from

\* From the Department of Internal Medicine, University of Southern California School of Medicine and the Los Angeles County General Hospital, Los Angeles, Calif.

the files of the Lahey Clinic where on the basis of roentgenologic findings, the diagnosis of diverticula of the stomach had been made in thirty-five patients. More recent reports have been presented by Hunter,<sup>9</sup> Frank,<sup>10</sup> Paulson<sup>11</sup> and Telford.<sup>12</sup> Bockus<sup>13</sup> in his book on gastroenterology estimated that more than 150 cases of gastric diverticula had been reported prior to 1943.

*Classification.* The greater portion of discussion found in literature with reference to the classification of gastric diverticula is of theoretical importance only and much of this is confusing to say the least. One of the more standard<sup>3</sup> classifications subdivides these abnormalities as follows: (1) True diverticula—those in which all layers of the gastric wall are present without definite evidence that organic disease played an etiologic rôle and which are probably congenital in origin. (2) Acquired, true diverticula—those in which all layers are present although there may be thinning of the gastric layers with evidence that some disease was an etiologic factor. (a) pulsion type resulting from intragastric pressure; (b) traction type secondary to extragastric adhesions. (3) False diverticula—resulting from a break in the gastric wall secondary to disease.

According to this classification, penetrating ulcers both benign and malignant might fall into the third subdivision of false diverticula. This would appear only to confuse the issue. Furthermore, it is neither certain that all congenital diverticula present an intact replica of the gastric wall<sup>14</sup> nor that all acquired diverticula show a mural deficiency.<sup>15</sup> Martin<sup>4</sup> has collected fifteen cases of diverticula which showed islands of pancreatic tissue in the tip. These are considered to be of the congenital variety.

From the standpoint of the clinician a classification based on a rigid separation of congenital from acquired diverticula does not prove practical. This differentiation cannot be made by roentgenologic examination and in the final analysis, according

to most definitions, diagnosis rests in the hands of the pathologist following microscopic examination. In order to eliminate the possible inclusion of penetrating ulcers in this category of gastric disorders a prerequisite for diagnosis of a diverticulum is that it be lined by gastric mucosa. Obviously ulceration may involve this lining secondarily; however, the mucosa will be found to dip into the out-pouchings in marked contrast to the histology observed in ulcer craters.

In the interests of simplicity and practicality a morphologic classification will probably prove more satisfactory than an etiologic one, especially since the etiology is so often questionable. The following classification is offered: (1) True diverticula in which all layers of the gastric wall are present. (2) False diverticula in which all or part of the muscular layers or serosa may be absent.

While most true diverticula are congenital and most false diverticula are acquired, there is no reason why pulsion or traction may not play an etiologic rôle in true diverticula nor why false diverticula may not be either congenital or acquired in origin.

#### ETIOLOGY

Formation of a gastric diverticulum is dependent on the existence of a "locus minoris resistentiae." This may be an intrinsic mural weakness secondary to deficient or faulty muscle arrangement or it may be extrinsic in origin secondary to inflammatory contractures or increased luminal tension. Frequently a combination of the aforementioned factors completes the picture.

The cardiac region of the stomach is that most frequently involved by gastric diverticula<sup>10</sup> and it is in this region that one finds two contributing factors to the mural defects: first, a muscle deficiency and second, an abundant penetration by large vessels. The longitudinal muscular fibers of the stomach thin out as they approach the cardia until there are portions in which

the mucosa is supported only by a rather thin layer of circular fibers. A somewhat similar situation exists at the pharyngo-esophageal junction, another site for diverticula. Cunha<sup>16</sup> has aptly described this area of muscular deficiency in his lucid presentation of drawings and microscopic sections.

The coeliac axis lies in close proximity to the cardio-esophageal junction and numerous branches from the left gastric, inferior left phrenic and the splenic arteries pierce this portion of the stomach. It stands to reason and is borne out by actual observations made during surgical operations (two case reports presented by the authors) that these penetrating vessels might very well play an important rôle in the genesis of diverticula, not only in the formation of a mural hiatus but also in the fact that the vessels themselves act as traction factors.

Considerable credence is given the etiologic rôle of pulsion and traction by Martin<sup>4</sup> who classifies diverticula into these two types. If certain points of mural weakness associated with conditions in which there is increased intragastric tension or extragastric adhesive traction exist, the stage is set for possible development of a diverticulum. Cunha<sup>16</sup> validates this sequence in his case reports in which three patients had pyloric obstruction and two gave a history of pertussis with chronic severe cough. Jordan and Lahey<sup>17</sup> believe that perigastritis plays a rôle in formation of traction diverticula. Numerous case histories describe adhesions from the surrounding viscera and the abdominal wall which must be construed as playing an important part in the genesis of certain gastric diverticula.<sup>2,3,12,18-21</sup>

*Location.* Diverticula may be located anywhere in the stomach but the most frequent site is on the posterior wall of the cardia.<sup>8,22-24</sup> Martin<sup>4</sup> in his study of 103 cases found that 61 per cent of the diverticula were situated within a few cm. of the cardia. These will usually be found to lie on the posterior wall near the lesser curva-

ture and within 3 cm. of the esophageal opening. The next most common site is adjacent to the pylorus, more frequently along the lesser than the greater curvature. Shifflett<sup>25</sup> in his series of forty-three collected cases reported 65 per cent to be located at the cardiac end and 23 per cent near the pylorus with the remainder involving various other parts of the stomach.

*Incidence.* Owing to the infrequency of this condition, most of the reports deal with single or small groups of cases which makes it rather difficult to collect accurate statistics as to incidence. Gastric diverticula, with the exception of the ileojejunum section, are the least frequent of all gastrointestinal out-pouchings. Shifflett<sup>25</sup> made 768 roentgenologic studies with the following incidence of diverticula: colon, 4.96 per cent; duodenum, 3.74 per cent; esophagus, 0.79 per cent; stomach, 0.65 per cent and only one case of a diverticulum of the small bowel. In 19,022 roentgenologic examinations Reich<sup>24</sup> found only six cases. Rivers et al.<sup>3</sup> found ten cases in 11,234 consecutive exploratory operations on the stomach and made twenty-five roentgenologic diagnoses of gastric diverticula in the course of 91,532 routine roentgenologic examinations of the stomach. Rigler and Erickson<sup>26</sup> reported two cases in a series of 4,236 roentgenologic examinations of the stomach.

Shifflett<sup>25</sup> made an analysis of his series of forty-three collected cases as to sex and age incidence. He found males made up 44.2 per cent and females 55.8 per cent of the series. As to age periods there were in the first decade two patients, the second decade none, the third decade six patients, the fourth decade eleven patients, the fifth decade thirteen patients, the sixth decade nine patients and beyond this age there was one patient.

*Pathology.* The usual histology of the uncomplicated true diverticulum reveals all layers of the gastric wall to be continued, possibly with some thinning, throughout the out-pouching. In the case of false diverticulum one usually finds the gastric

mucosa and submucosa to be intact while the muscular layers will thin out and end abruptly near the border. The serosa is frequently absent in the presence of adhesions such as are found in the traction type of diverticula.

Martin<sup>4</sup> has collected a series of fourteen cases in which islands of pancreatic tissue were observed in the apex of the diverticula whose walls otherwise were made up of normal-appearing gastric layers. In all but one of these the location was at the pyloric end. Gile<sup>27</sup> presented a case of gastric diverticulum which showed typical colon mucosa on about one-half the wall and pyloric type of mucosa on the remainder. Rivers<sup>3</sup> reported a sarcoma in the wall of one patient and an adenomyoma in another. Mayo<sup>28</sup> and Mellon<sup>29</sup> each report a case of carcinoma in the wall of a gastric diverticulum.

Perusal of the literature fails to reveal many of the complications found more frequently in diverticula of other portions of the gastrointestinal tract. Acute perforation, frank diverticulitis and strangulation are not reported in the available literature. Hartley<sup>30</sup> reporting in the *British Journal of Radiology* presents a most intriguing set of x-rays showing a large gastric diverticulum in a left inguinal hernial sac.

#### SYMPTOMATOLOGY AND DIAGNOSIS

From the standpoint of symptomatology there is no particular or specific pattern which fits this clinical entity and anyone who has persistent epigastric distress must be considered as possibly having a gastric diverticulum. The usual sequence of events resulting in a diagnosis is a group of symptoms related to the gastrointestinal tract, a diagnostic barium meal and then, instead of the discovery of an ulcer or a muscular dysfunction, the investigator finds a diverticulum.

The next problem confronting the diagnostician is whether or not the newly discovered pathologic condition is the etiologic factor in the symptomatology. The diverticulum is usually asymptomatic

and one must think twice before explaining symptoms upon the basis of demonstrating such a condition. Further examination may reveal a gastric or duodenal ulcer thus showing the diverticulum to be an incidental finding.

The diagnosis rests entirely with a careful roentgenographic examination. The sac, if located in the most common site at the cardiac end of the stomach, is visualized immediately after the barium enters the stomach. However, follow-up studies are most important. Retention of barium in the diverticulum after four hours indicates poor emptying of the sac and probably indicates that a symptomatic condition is present. It is true that in the differential diagnosis two conditions must be considered: first, perforated peptic ulcers and second, ulcerative carcinoma of the stomach. It is not the purpose of this paper to go into a detailed account of the differential diagnosis but if in doubt it may be necessary to resort to gastroscopic examination.<sup>13</sup>

#### TREATMENT

Medical treatment should be instituted before surgery is considered. This treatment consists of postural drainage, small frequent feedings and antispasmodics. It is true that many of the cases reported in the literature had neuropsychiatric symptoms and evaluation of such symptoms are extremely important before any surgical procedure is considered. If after six weeks of medical regimen and proper psychiatric evaluation the patient is still symptomatic, surgery should be contemplated. The surgical procedure, while reported by some authors as extremely difficult,<sup>8</sup> was carried out in our two patients without serious technical difficulty.

The approach to most gastric diverticula is best made by a midline incision. In certain cases of fundal diverticula a trans-thoracic approach may prove satisfactory.<sup>11</sup> In the two cases presented the diverticula was exposed by section through the gastocolic and the gastrosplenic ligaments with rotation of the stomach to the right. Even

though the pathologic out-pouching lay closer to the lesser curvature, the approach was technically easier around the more flexible greater curvature. (Figs. 1 to 3.)

ing antacid, antispasmodics, frequent feedings and the convalescent ulcer diet produced no relief of symptoms.

On February 8, 1946, surgery was performed

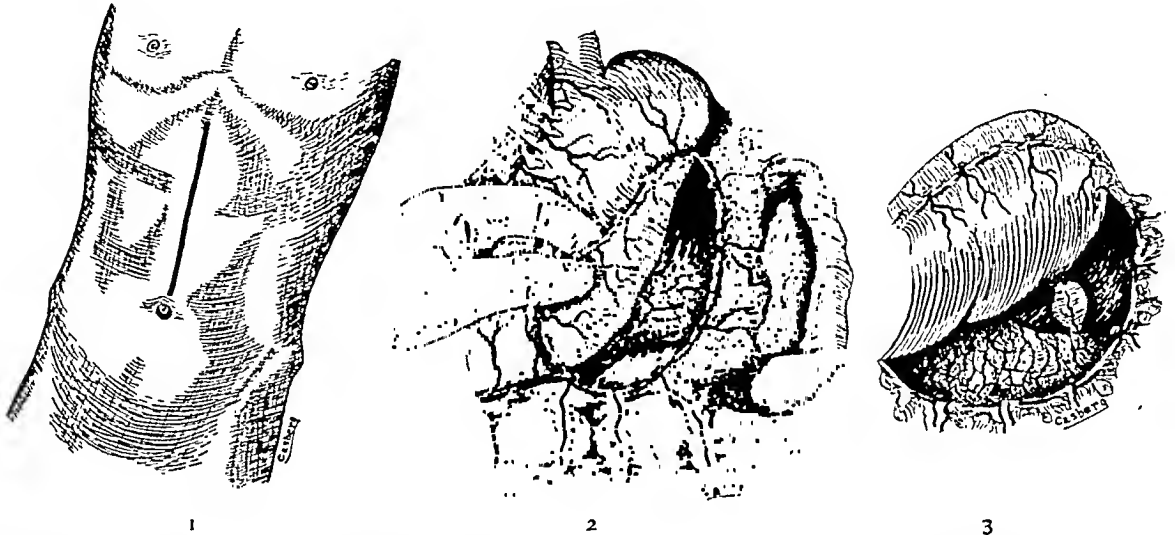


FIG. 1. Midline xipho-umbilical incision which can be extended inferiorly or transversely should the need arise. In the exposure of certain parts of the fundus a transthoracic approach may be utilized.

FIG. 2. The greater curvature of the stomach being more mobile an approach through the gastrosplenic and gastrocolic ligaments with rotation of the stomach to the right proved more satisfactory than an approach by way of the lesser curvature and gastrohepatic ligament.

FIG. 3. A fairly large branch of the splenic artery was found running into the apex of the diverticula in both cases. This is of interest from the standpoint of etiology, both as a factor of intrinsic weakness in the gastric wall and also as an element of traction.

#### CASE REPORTS

**CASE 1.** Mrs. W. K., aged forty-eight, a housewife, complained of intermittent burning and gnawing pains through the mid-chest during the preceding five years. She stated that occasionally she had the sensation of having had food stuck in her chest. There had been no weight loss. The pain was more severe when the patient lay on her left side and it was occasionally relieved to some degree when she lay on her right side.

Examination revealed a well developed, fairly well nourished, adult female in no acute distress. Complete physical examination revealed no abnormalities. X-ray study of the stomach demonstrated a diverticulum of the lesser curvature at the cardiac end of the stomach, posteriorly, immediately below the esophageal orifice. (Fig. 4.) At three and twenty-four hours after ingestion barium was still retained in this diverticulum. (Figs. 5 and 6.) Gastric analysis of fasting specimen revealed no free acid and a combined acidity of 14 degrees. The sedimentation rate was 12 mm. There was no anemia. Medical regimen includ-

and a diverticulum was found in the posterior aspect of the stomach near the lesser curvature just distal to the esophagus. The diverticulum was attached to the posterior abdominal wall by a vascular pedicle which entered the pouch at its apex. The diverticulum was 2 cm. in diameter and had a large sessile base. It was removed and the postoperative course was uneventful. Pathologic report revealed the presence of gastric mucosa, muscularis mucosae and submucosa but no muscularis or serosa. There was extensive inflammatory reaction in the mucosa which consisted chiefly of lymphocytes. Follow-up x-ray of the stomach on March 29, 1946, revealed a normal stomach. (Fig. 7.)

The patient continued to complain of gastric distress following surgery and she was placed on a strict ulcer regimen. On the 29th of April it was found that she had gained weight and her general condition had improved. However, as yet her case cannot be classed as a complete cure because of the marked functional element involved which requires further treatment. There has, however, been definite improvement and the diverticulum has been removed.



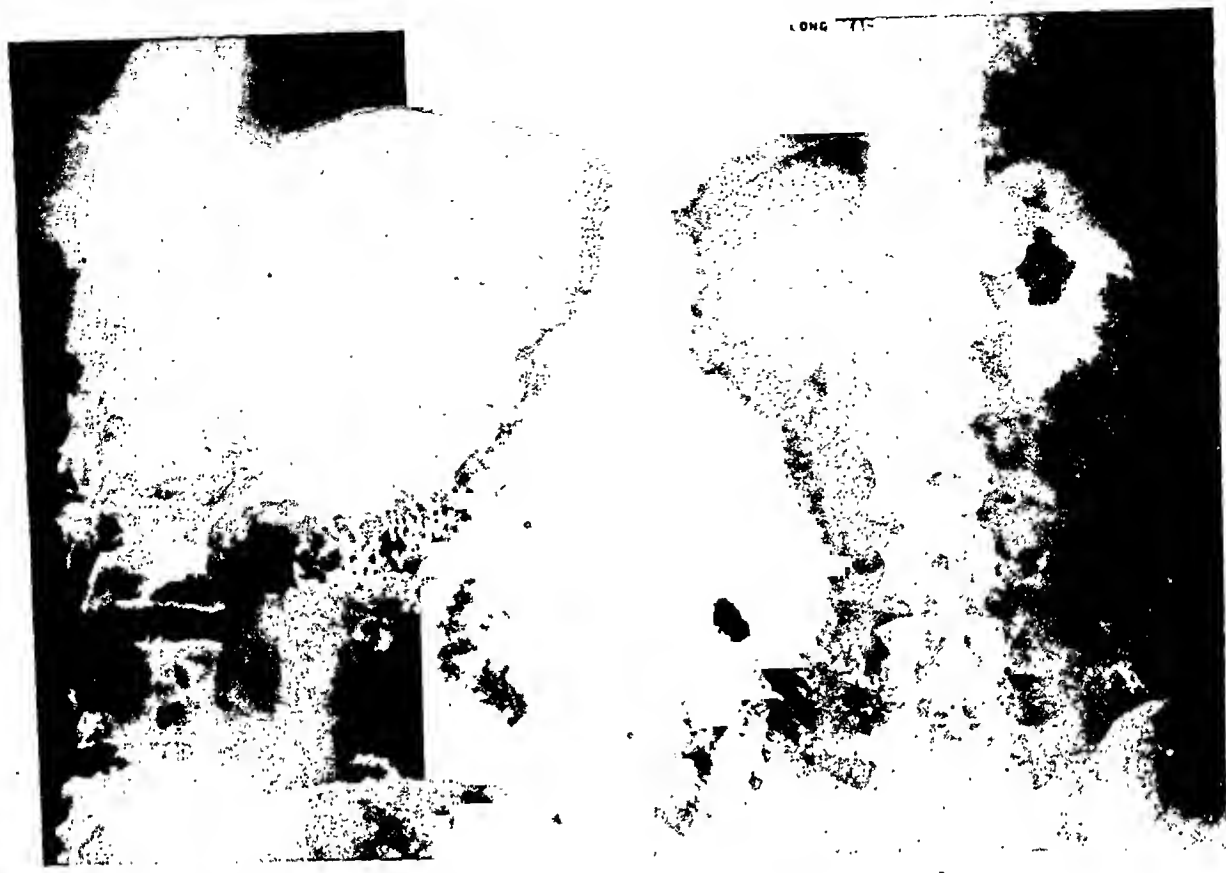


FIG. 4. X-ray following barium meal in Case 1 showing a diverticulum at the cardiac end of the stomach posteriorly, immediately inferior to the esophageal orifice.

FIG. 5. X-ray in Case 1 three hours after ingestion of barium with diverticulum clearly outlined.

CASE II. Miss M. R., aged nineteen, telephone operator, complained that during the last year she had had epigastric pain occurring one hour after meals. The pain was aggravated by cold drinks. There had been moderate anorexia and a loss of 10 pounds in weight during the past three months. Antacid and ulcer regimen gave no relief. There was thought to be a strong functional element and the patient was advised that she should be careful to evaluate her symptoms and was assured that no definite benefit could be promised by surgery. Attempts were made to increase her weight by administration of amino acids and frequent high calory feedings but her symptoms persisted. The patient complained that she could not endure the nocturnal epigastric pain which caused her to remain awake most of the night and she insisted upon surgery.

Surgery was performed on March 29, 1946, and a large diverticulum was found in the posterior surface of the stomach near the lesser curvature about 1 inch below the esophageal orifice. The diverticulum was pedunculated, in

that the opening into the stomach was narrow. Two large vessels, branches of the splenic arteries, penetrated the gastric wall in the region of the base of the diverticulum. The pathologic report revealed only the mucosa and submucosa and a moderate amount of chronic inflammatory reaction. The diagnosis was chronically inflamed gastric diverticulum.

Preoperative x-ray diagnosis revealed a diverticulum of the stomach on the posterior wall, about 2 cm. in diameter, located approximately 1 inch below the cardiac orifice. (Fig. 8.) Examination at four hours after the barium meal revealed retention in the diverticulum. (Fig. 9.) Incidentally, x-ray examination of the stomach done at another hospital on January 6, 1946, about six weeks before the patient was operated upon, failed to visualize this diverticulum although a later study of the films made at that time revealed evidence of the diverticulum. X-ray examination of the stomach six weeks after operation gave no evidence of gastric diverticulum. Postoperative x-rays gave evidence of some gastric retention indicating





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FIG. 6. X-ray in Case 1 twenty-four hours after ingestion with barium still retained in the diverticulum.

FIG. 7. X-ray follow-up in Case 1 after surgery showing a normal stomach outline.

pyloric spasm. (Figs. 10 and 11.) After twenty-four hours the stomach was empty. The patient was given antispasmodics and a bland diet for about three weeks following surgery. This management proved to be very successful. There was no recurrence of nocturnal pain and the patient regained her lost weight. In a follow-up study it was found that there was no recurrence of the pain described in the original complaint although the functional element was still strong and reassurance was necessary to help the patient through the period of uncertainty which might have been expected in such a condition.

The results of all laboratory work, including complete blood count, urinalysis and sedimentation rate, were within normal limits preoperatively. Gastric analysis preoperatively revealed 20 degrees of free acid which was considered to be within normal limits after an alkaline meal.

A survey of the records at the Los Angeles County General Hospital for the period 1929 to 1945 revealed that six patients had been found to have gastric

diverticula. The total admissions for this period were over 700,000. The figures indicate, therefore, that approximately .0008 per cent of all patients admitted during this sixteen-year period were found to have gastric diverticulum. However, there probably were some among these patients who had gastric diverticula but were without symptoms and thus it was not recognized. Of these six patients the following information was obtained:

**Case 1:** A case of a seventy-four year old white female who had had no clinical symptoms related to her digestive apparatus. Gastric diverticulum in the lower portion of the greater curvature of the stomach was found at autopsy. The patient died of congestive heart failure.

**Case 2:** This was a case of a fifty-four year old white female who gave no complaints relative to her digestive tract. On routine x-ray examination of the stomach she was found to have a diverticulum 1 cm. in diameter in the cardiac portion posterior

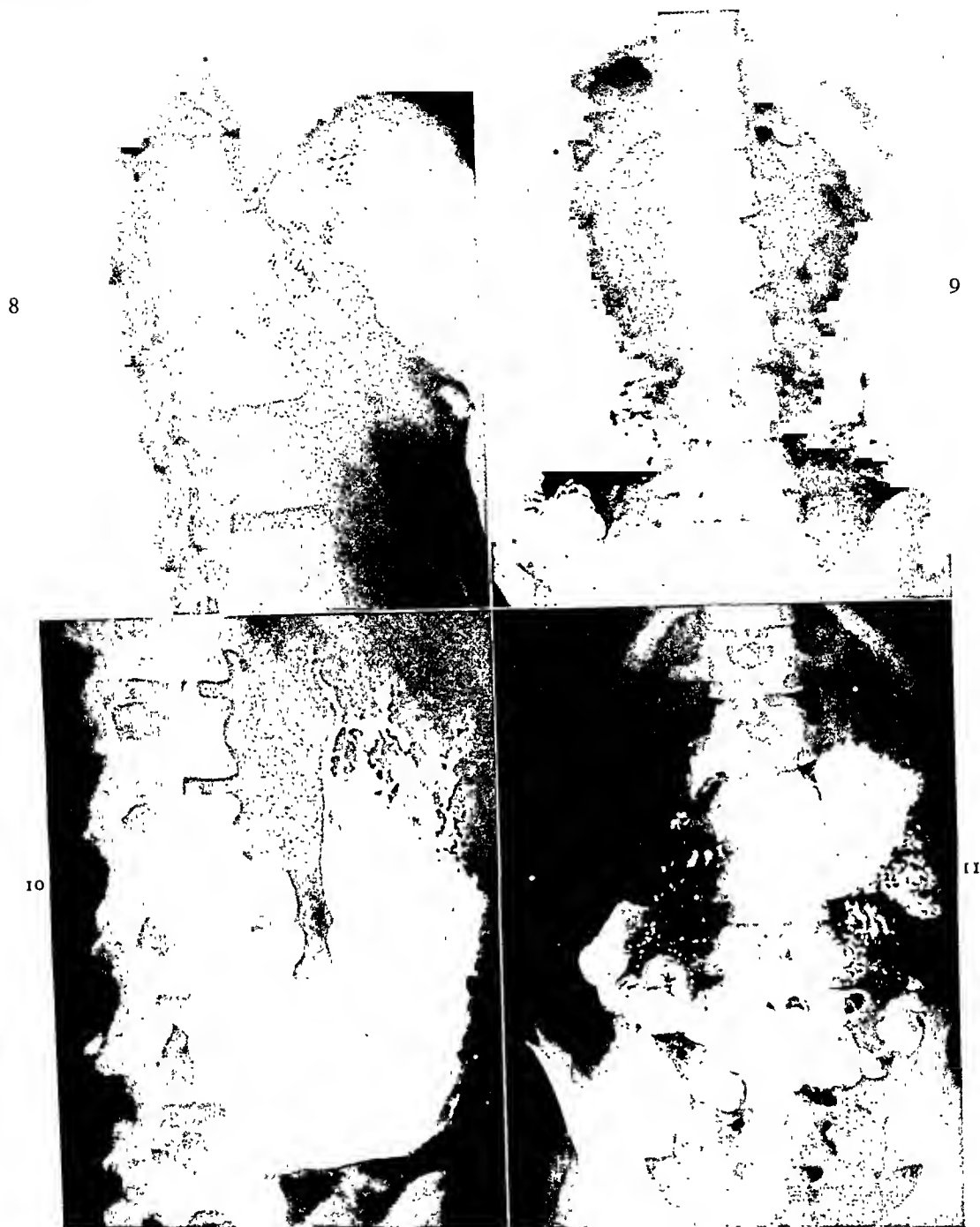


FIG. 8. X-ray following barium meal in Case 11 showing a diverticulum of the stomach at almost the identical location as in Case 1.

FIG. 9. X-ray in Case 11 four hours after barium meal showing retention in the diverticulum.

FIG. 10. X-ray of the stomach in Case 11 six weeks after operation and immediately after barium ingestion showing normal outline.

FIG. 11. X-ray in Case 11 taken four hours after that in Figure 10 showing incomplete emptying of stomach.

to the esophageal opening. The patient was treated for congestive heart failure and ascites.

*Case 3:* This was a case of a forty-two year old white male who gave a history of excessive alcoholism. He had had acute abdominal pain and black stools for three days. X-ray examination revealed a diverticulum in the anterior aspect of the stomach attached to the fundus by a long pedicle. There was evidence of antral spasm. On conservative treatment the patient's condition improved and he was discharged.

*Case 4:* This patient was a fifty year old white female who gave a history of acute abdominal pain of three days' duration. X-ray examination gave evidence of a sacular dilatation of the proximal portion of the greater curvature at the pylorus. Gastric resection was performed. Microscopic study revealed a chronic, diffuse gastritis and atypical gastric mucosa in a diverticulum of the stomach. The patient expired about two weeks postoperatively. The diagnosis was postoperative diverticulum of the stomach, bronchopneumonia and syphilis of the central nervous system.

*Case 5:* The patient was a forty-four year old white female who complained of burning pain in the epigastrium and a loss of 25 pounds in weight during the preceding year. X-ray examination revealed a gastric diverticulum 2 by 3 cm. in diameter below the esophageal orifice. The patient was operated upon and the postoperative diagnosis was diverticulum and polyposis of the stomach. No follow-up studies were made.

*Case 6:* This was the case of a sixty-four year old white female who gave a history of nausea, epigastric distress and weight loss extending over a period of eight years. X-ray revealed a diverticulum in the superior posterior aspect of the stomach. Surgery was advised but was refused by the patient. No follow-up study was made.

#### SUMMARY

1. Gastric diverticula, with the exception of those in the ileojejunal section, are

the least frequent of all gastrointestinal diverticula.

2. In the interests of simplicity and practicality a morphologic classification will prove more satisfactory than an etiologic one. (1) True diverticula in which all layers of the gastric wall are present and (2) false diverticula in which all or part of the muscular layers and perhaps serosa are absent.

3. Formation of a gastric diverticulum is dependent on the existence of a "locus minoris resistentiae." This may be an intrinsic mural weakness secondary to deficient or faulty muscle arrangement, or it may be extrinsic in origin secondary to inflammatory contractures or increased luminal tension or a combination of all or part of the aforementioned factors.

4. The most frequent site of gastric diverticula is on the posterior wall of the cardia.

5. There is no syndrome pattern which fits the clinical entity of gastric diverticula.

6. Diagnosis is usually made during the course of a gastrointestinal x-ray series in the process of searching for the cause of vague symptoms of epigastric distress.

7. As many gastric diverticula are asymptomatic one must not attribute existing symptoms to such a condition unless other possible gastrointestinal disorders have been ruled out.

8. Therapy should at first be conservative, including medical management and psychiatric evaluation. Should symptoms persist then one should resort to surgery.

9. The surgical approach used in the two cases herein presented was through a midline incision and around the greater curvature of the stomach. This afforded good exposure of the diverticula in both instances.

10. Two personal case histories are presented in detail as well as six cases from the Los Angeles County General Hospital.

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# HEMORRHAGIC SHOCK

CHARLES M. SWINDLER, M.D.

*New York, New York*

THE purpose of this paper is to describe in some detail the problems of hemorrhagic shock as seen in the European Theater together with their method of handling and the lessons learned. The details outlined herein are a summation of the experience of the various surgeons and shock officers of an Auxiliary Surgical Group. The material has been culled from the personal files of the surgeons, official reports of the surgical team heads and from a monograph on acute traumatic surgery by the consultant surgeon for the Mediterranean-Italian Theater. Experiences are drawn from Tactical Operations of the Fifth and Seventh Armies. They commence with the beach-head operation of North Africa and end with the drive for central Germany. These experiences have for their background: (1) the airborne operation in the Low Countries, (2) Tunisian desert campaign, (3) various Italian river crossings and (4) battles associated with the Bulge and the Siegfried Line.

The shock officer is primarily concerned with the problems of shock and his duties are the supervision and treatment of all shock which occurs in battle casualties. This officer works in the most forward Field Hospitals where the patients treated are so critically wounded that they cannot be transported to the rear. Treatment of acute blood loss in these patients is the first responsibility of the shock officer. It is his duty to see that suitable blood replacement is carried out by blood transfusions and blood plasma. The amount and type of blood used or the use of blood derivatives are decisions which the shock officer has to make and are predicated on the clinical condition of the patient when he arrives in the shock tent.

Churchill states: "Restoration of blood

volume and the relief of hypo-tension and anoxia must be done without loss of time. Replacement therapy forms the basis of resuscitation. Whole blood in large amounts is mandatory. One can speed resuscitation by simultaneous infusion of blood into one vein and plasma into another vein or into the sternal medullary cavity."<sup>1</sup> The important thing to remember, however, is that whole blood must be rapidly infused into the circulatory system even under pressure if the peripheral vasomotor collapse is so profound as to prevent the normal operation of the classical Baxter sets which we employed routinely. (By rapidly we mean 500 to 1,500 cc. in twenty minutes). Unfortunately, the idea has developed that the treatment of shock rests upon the restoration of blood volume. This is false reasoning. "The dominant factor in shock is the loss of *blood* into the wounded tissues, into body cavities, and to the surface. The successful treatment of shock, therefore, not only rests upon the restoration of blood volume, but also upon the restoration of hemoglobin as well. Infusions of plasma alone will not suffice. Beyond a certain point, plasma may do harm by diluting the remaining red blood cells at a time that the rising blood pressure increases hemorrhage. A false sense of security may be created by the elevation of the systolic blood pressure under these circumstances. A blood pressure brought to normal or nearly normal levels by plasma alone, may fail precipitously with the induction of anesthesia, operative manipulation, or merely moving the patient."<sup>1,2</sup>

The preparation of the critically injured battle casualty for surgery requires the utmost in keen surgical judgment and astute surgical diagnosis. Appraisal of the patient's condition demands the sum total of the surgeon's clinical knowledge. So, too,

the shock officer must be ever alert and mentally active for it is he who will care for the patient during the surgeon's absence or until such time as the surgeon can render his opinion. Reactivation of hemorrhage may occur as the circulation improves. If continuing hemorrhage is suspected, the surgeon must proceed with the indicated operation while blood is being transfused into one or more veins. If the state of shock does not improve and/or respond rapidly to infusion of blood and plasma, it is a fair assumption that there is continuing hemorrhage, established infection or that the continuing shock is associated with other injuries, for example, intracranial damage, transection of the spinal cord or open wounds of the thoracic cavity with the resultant disturbance of the cardiorespiratory physiology. One of our problems of shock is: When is a patient ready for surgery? There is no specific answer. Each case is a problem in itself, but the shock officer must hold the key to the situation. His duty is to save life; it is also his duty to restore a patient to a state of equilibrium which will permit the necessary surgical procedures. The shock officer outlines and carries out an individualized plan of shock therapy for each critically injured battle casualty admitted to his tent.

Of all the drugs and procedures developed for the treatment of hemorrhagic shock, none has stood up under the critical test of forward surgery with the exception of replacement therapy. External application of heat and the use of morphine are two time-honored measures in the treatment of shock which, if used injudiciously, could cloud the picture considerably. "The external application of heat can be dangerous if overdone."<sup>2</sup> Fluid loss in the desert campaign and the drive for Rome was great even in the normal man. What would it be like in a man with dysfunction of the vasomotor system due to shock? Morphine is advisable only in moderate amounts and its use is limited to the excited patient.

"Morphine is not indicated for the

treatment of restlessness of hemorrhage, which is largely due to anoxia."<sup>2</sup> The "q.s. ad libitum" prescription for morphine can lead only to dire end results in two types of patients: (1) the patient with acute hemorrhagic shock and (2) the patient with an invasive anaerobic cellulitis infection.

The patient with acute hemorrhagic shock has no functioning peripheral vascular system and consequently no functioning route of assimilation. Morphine given to this type of patient by the usual route of administration does nothing more than pile up in the tissues adjacent to the site of injection. This produces a pernicious situation because there is delayed absorption of the drug. When the peripheral circulation is improved by resuscitation therapy, a manifold absorption of the piled up morphine ensues with resultant acute morphine poisoning.

A patient with acute invasive anaerobic cellulitis will have his diagnostic findings masked if injudicious morphine medication is given him. "The diagnosis of clostridial myositis in a field hospital is entirely clinical and is based in great part on minute alterations of the patient's psychic pattern."<sup>3</sup> Clostridium Welchii infections make for the apprehensive, hyperexcitable, occasionally maniacal type of personality change, whereas infections caused by Cl. perfringens and oedematiens project the mental pattern into the comatose category. In a case of clostridial myositis the mental base line must be established. Morphine medication militates against such a procedure and makes the diagnostic estimate most difficult.

We know that morphine is a good drug but it is also a two-edged sword. In the types of patients which we have described, morphine is indicated for definite and unequivocal pain only, and the route of administration should be intravenous to avoid additive effect. Use the drug to the limit but use it wisely and judiciously. The differential diagnosis between acute fulminating clostridial oedematiens infec-

tion and morphinism is not easy; the treatment of acute hemorrhagic shock complicated by morphine poisoning is not a simple task.

#### TYPICAL CASES OF SHOCK

*Head and Face Injuries.* The average head injury, if the patient lives for six hours, usually does not present much of a problem. In most cases the injury is such that the patient decompresses himself. The problem with head injuries is not as a rule too difficult to solve because the shock is not primarily due to acute blood loss unless there is an associated transection of one of the major vascular bundles. From the point of view of the shock officer straight forward head injuries are best managed by establishing an adequate airway and supplying hypertonic fluids. "Twice concentrated plasma" and serum albumin are the usual agents available in front line hospitals for this form of therapy. The establishment of an airway, especially in patients with associated facial injuries, resolves itself into performing a tracheotomy. If there is any doubt as to the embarrassment of the airway in a facial injury, it should mandatorially point to a tracheotomy. We always believed that adequate oxygenation was a very important phase of shock therapy and failure to maintain adequate oxygenation was to sign and seal the death warrant of the patient involved.

*Chest Injuries.* In chest wounds the important problem is the restoration of the normal physiology of the cardio-respiratory system. Shock treatment in this type of injury is based upon the alleviation of the asphyxia, control of the pulmonary edema and the negation of tension pneumothorax. Actually, surgery in chest wounds is a secondary consideration. The primary consideration is shock due to altered respiratory function. The treatment of this special form of shock is immediate and rapid aspiration of the pneumothorax, closure of the perforation if there be one, control of pain by intercostal block, drying out of the tracheobronchial tree by cathet-

erization and nasal oxygen medication and the prompt release of tension pneumothorax through a water seal. Finally, the crux of shock therapy in chest injuries is adequate stabilization. The knowing when to operate on a chest injury is just as important as knowing how. One must answer these questions: Is that portion of the functioning lung field dry? Has the patient's hemoglobin been restored to reasonably normal levels? Can the patient withstand additional asphyxia in the form of anesthesia?

*Abdominal Injuries.* Penetrating wounds of the abdomen will test the shock officer's diagnostic acumen to the nth degree. Patients with traumatic, intra-abdominal wounds have a most unstable vasomotor system. While their shock may well be ascribed to hemorrhage, one must keep in mind that irritative peritoneal contamination in the form of feces, bile, blood and urine alone cause profound shock and death. This untoward reaction is most often seen after injuries to right colon, ileum, and cecum whose contents are notably irritative. The heat and fluid loss of intestinal eviscerations and the acute pain of stomach avulsions are also major contributory factors in the cause of shock in abdominal injuries. The treatment of these patients is perforce blood. How much blood one will give is predicated upon several factors: (1) rise in blood pressure, (2) stability of blood pressure, (3) hematocrit and plasma protein readings as determined by the Evans copper sulfate method, (4) clinical appearance of the patient and (5) the tactical situation with its associated operating load.

In addition to blood there are other therapeutic agents which are essential in the treatment of shock in abdominal injuries. The stomach should be decompressed as soon as the patient arrives in the shock tent. The reasons for the use of a gastric suction tube in gut injuries are obvious. The employment of the gastric suction tube in other conditions is also of value. In pregnancy the processes of

gastric motility cease with the onset of labor. So, too, when a man is critically injured, his gastric functions temporarily cease. Immediately acute gastric dilatation sets in. This causes pain but it also raises the diaphragm on the left side and thereby reduces pulmonary ventilation. The reduction of available aeration space in the lung is the one thing one does not want in shock; certainly it is an undesirable factor in thoracic, abdominal and thoraco-abdominal wounds.

Another factor which will reduce vital capacity is the voluntary splinting of the abdominal musculature and its concomitant decrease of the costal excursion. Penetrating wounds of the upper abdomen notoriously develop well lung and it is our opinion that part of this may be attributed to this abdominal splinting. The well trained shock officer will be thinking about muscular splinting at all times. Sensation of the abdominal wall arises from the ninth thoracic through to the twelfth. Treatment of upper abdominal wounds, in part, should be directed toward blocking the previously mentioned innervation. It is in this fashion only that the patient can be prevented from reducing his vital capacity by muscular splinting of the abdominal wall. A shock officer has only to treat the pulmonary edema which arises from poor ventilation once; he will ever after keep this important matter in mind.

*Extremity Injuries.* The cause of shock in straight forward fracture cases seen in civilian life has never been too well accepted by all. Various theories have been advanced, all of which are basically sound. But the cause of shock in extremity wounds due to shell fire and mines is obvious. These patients manifest such pathologic conditions as fracture of the long bones with and without extensive comminution and/or soft tissue loss, major vascular injuries complicated by hemorrhage, traumatic amputations both partial and complete, penetrating wounds of the joints, transections of the major nerves and penetrating wounds of the thighs with asso-

ciated perforations of the bladder, rectum and peritoneal cavity. A complication not infrequently seen in extremity wounds is anaerobic cellulitis both invasive and non-invasive. Any one or a combination of these factors will produce shock of a profound degree. The problem for the shock officer in evaluating a given case is to determine what factor or factors are producing the shock.

The loss of blood from a lacerated artery is apparent, but the loss of blood from venous back pressure due to an improperly applied tourniquet is often without reckoning. Frequently patients have been exsanguinated because of a tourniquet sufficiently tight to occlude the venous return but not the arterial supply. This is not the fault of the tourniquet but rather the method by which it was applied. The shock officer must be ever watchful of this procedure because it does happen more often than one realizes and it can be not a little embarrassing. The use of tourniquets in any case is very limited. The good shock officer can control all hemorrhage in extremity wounds either by direct pressure over the wound or by ligature of the offending vessel. If a tourniquet must be applied, it should be applied as low as possible. There are good reasons for this remark. In the first place, why compromise the vitality of the entire leg by placing a tourniquet over the femoral trigon when the patient has a traumatic amputation through the ankle. To compromise the vitality of an extremity in this fashion not only reduces the prospects of getting a good operative result but it also invites the development of anaerobic cellulitis in tissue which would otherwise be healthy had its blood supply not been impaired. Another reason for placing the tourniquet so low is that we wish to prevent the dissemination of myoglobin and exotoxins of clostridia from the local site of trauma.

Extremity wounds present another situation which at times can be most confusing. This is infection with anaerobic organisms. Anaerobic infections are important to the



shock officer because they are so often the etiologic basis for the patient's shock. Patients with extremity wounds can and do go into shock three hours after wounding and a frequent cause is acute invasive anaerobic cellulitis. Unfortunately, the diagnosis of such conditions is entirely clinical. Were we to see infections due primarily to *Clostridium Welchii* and *Clostridium perfringens*, the matter would be relatively simple. The crux of the argument is that infection caused by these organisms is not always the common finding. "Intensive studies carried out in Sicily, Italy, and France disclosed that *Cl. Bi-fermentens*, *Oedematiens*, and *Sordelli* infections were also frequent offenders."<sup>3</sup> It was the toxemia elaborated by these organisms which threw the patient into decisive, profound and rapidly fatal shock. The existence of these organisms with their fulminating type of infection should be borne in mind at all times because their diagnosis all too often hangs by the fine thread of an unstable blood pressure, a rapid pulse, minute changes in the general condition with alterations in the psychic pattern and mental behavior.

#### UNFAVORABLE RESULTS

The shock officer will have many disappointments no matter how astute he might be or how hard he works. He will have many mistakes written to his credit; his work by definition will make for a high mortality rate. The author in an attempt to learn wherein he had failed spent several months in the Pathology Department of a medical laboratory studying the post-mortem findings of his errors.

When the protocols of the various cases were studied, and this includes many of those patients who were operated upon by surgical teams of the auxiliary surgical group but who never fully recovered from shock, two contributory causes of death were noted: (1) fat embolism and (2) hemoglobinuric nephropathy.

"There were two significant points noted in cases of fat embolism: (1) It was seen

in cases who had severe fractures and/or traumatic amputations and (2) it was rarely diagnosed clinically."<sup>4</sup> In the medical laboratory files there were records of approximately 200 patients who died from wounds in which major fractures were a predominating complication. Analysis of the tissue slides of these cases showed thirty of them to have fat emboli and this condition was apparently not recognized clinically. The author is not without guilt in this matter. He had two patients who died presumably of clostridial myositis. Microscopic examination of the tissues taken from these two revealed the diagnosis to be in reality fat embolism.

As further study of the autopsy protocols was carried out, it appeared that fat embolism had its origin in four types of conditions: (1) traumatic amputations, (2) fractures, (3) extensive tissue injuries to buttocks and (4) burns.

The clinical picture of fat embolism is highly imitative. Characteristically, the condition seemed to manifest itself forty-eight hours after operation or major manipulative procedure. But we often saw patients with severe comminuted fractures of the forearm who would arrive in the shock tent four hours after injury and then promptly die for no apparent cause. The mode of demise in these cases was "wet lung"; the cause of the wet lung—pulmonary fat embolism. In those patients who manifested their symptoms forty-eight hours after operation one saw initially respiratory embarrassment usually dyspnea, cyanosis and ultimately frank pulmonary edema. Further findings were those of a cerebral nature such as mental confusion, hyperexcitability, amnesia, aphasic phenomena and sometimes convulsions and coma. Various clinically unexplained localizing signs presented themselves. The clinician's diagnostic acumen was severely tested when such conditions as retinal hemorrhage or edema, motor paralysis and disturbance of the vegetative centers in the form of hyperthermia became apparent. Manifestations of this sort can be confused

with possible head injury and indeed they often were. One patient was diagnosed as a Waterhouse-Friedrichson's syndrome and another case was written up as "Typhus fever, acute severe." According to the histories both of these patients manifested mental confusion, hyperthermia, shock, petechial hemorrhages in the skin and meningismus. These were logical conclusions. Pathologically, the story was a different matter. The slides showed fat emboli in the brain, kidney, lungs and connective tissue.

Another contributory cause of death in several of these cases studied was hemoglobinuric nephropathy. Hemoglobinuric nephropathy is the sword of Damocles in those patients receiving massive transfusions (5,000 to 6,000 cc.). Hemoglobinuric nephropathy (shock kidney—transfusion kidney—kidney of crush syndrome) is a degenerative and proliferative type of lesion. The first thing seen in the microscopic section of the kidney are the pigmented casts located in the tubules. With formation of this cast an obstruction and a concomitant dilatation of the proximal nephrons develop. Edema of the interstitial tissue ensues and one sees connective tissue stroma infiltration with histiocytes, lymphocytes and eosinophiles. The tubular epithelium, as a compensatory measure for the blocking, proliferates occasionally to the extent of granuloma formation.

The casts are derived from one of two substances: (1) hemoglobin and (2) myoglobin. On the microscopic slide both of these substances have the same chemical characteristics. To differentiate them one has to resort to spectroscopic procedures.

From the surgical point of view, hemo-

globin, as seen in hemoglobinuric nephropathy, can be derived from three sources: (1) Transfusion of blood which is frankly incompatible, which may be due to mismatching or to the Rh factors which manifest themselves late (one to two months) and after many transfusions; (2) transfusion of hemolyzed blood, which has been stored blood past its expiration date or has been poorly prepared and/or cared for in the blood bank. (3) transfusions of *large amounts* of type "O" blood in a *short time*. The factor here is that with rapid transfusions hemolysis of the recipient's red blood cells takes place by A and B agglutinins contained even in low titer "O" blood. In other words, the protective factor of dilution, neutralization and excretion are negated.

#### SUMMARY

The dominant factor in shock is a loss of blood. The successful treatment of shock is predicated upon the rapid restoration of the normal hemoglobin content.

To have a thoroughly dry, patent, tracheobronchial tree with fully aerated, freely expansile, lung tissue is axiomatic. Tracheotomy, bronchial catheterization, intercostal blocks and oxygen medication are adjuvant procedures to which you must resort if you will treat shock successfully.

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# MECKEL'S DIVERTICULUM

A. V. MIGLIACCIO, M.D. AND CHARLES BEGG, M.D.

*Providence, Rhode Island*

THIS review covers the experience of the Rhode Island Hospital with Meckel's diverticulum and its complications during a twelve-year period beginning January 1, 1935 and ending December 31, 1946. The purpose of the review is twofold: First, several of the cases are of unusual interest; second, the review as a whole provides a means of self-analysis and self-criticism. It is our opinion that the Rhode Island Hospital represents an average, general hospital in a non-teaching center. For this reason our reflections, conclusions and experiences may benefit or at least interest similar institutions.

## HISTORIC AND EMBRYOLOGIC BACKGROUND

This aspect of the subject has been adequately treated in many publications.<sup>1,2,3</sup> The embryologic facts of pertinent interest may be briefly summarized: The omphalomesenteric duct, which connects the yolk sac with the intestine, begins to be obliterated in about the fifth week of fetal life. Obliteration is complete at about the seventh week. Various degrees of failure of obliteration lead to various disease entities. First, if the entire duct remains patent, a fecal fistula opening at the umbilicus results. Second, when the distal end fails to close, intestinal mucosa is seen at the umbilicus where the secretions of the glandular elements form a discharge. Third, a retention cyst is formed if the mid-section persists. Fourth, persistence of the proximal end may be seen as an out-pouching of the intestinal tract usually of the terminal ileum. This is what is commonly referred to as Meckel's diverticulum. It differs from other diverticula in that it contains all the layers of the muscularis of the intestinal wall. Occasionally associated with it is persistence of a fibrous stalk connecting its tip with the

inner aspect of the anterior abdominal wall in the region of the umbilicus. This is the result of incomplete regression of the omphalomesenteric duct. The blood supply of the diverticulum usually comes from its mesentery, which arises from the mesentery of the bowel, or it may come from the bowel wall itself in some instances.

## GENERAL CONSIDERATIONS

*Site of Diverticulum.* Meckel's diverticulum may arise from any portion of the intestinal tract although the terminal ileum is the usual site; it may arise from any point in the circumference of the bowel, including that area between the leaves of the mesentery. The usual point of origin is the anti-mesenteric border. In this series the extremes were a diverticulum arising only  $\frac{1}{2}$  inch from the ileocecal valve and one arising 2 feet proximal to the valve.

*Size.* The size varies greatly. The largest recorded in the literature is 104 cm.<sup>4</sup> although an average diverticulum is about the size of a thumb, no unusually large diverticula were encountered in this series.

*Incidence and other Statistics.* Figures derived from autopsy material show an incidence ranging from 1 to 2.5 per cent of patients coming to autopsy.<sup>2,3,6</sup> Various series show that the condition is more common in males than in females, the ratio ranging from 2.1 to 4.1.<sup>3</sup> In the author's series the ratio is three males to two females.

It is of interest to note the percentage of patients in whom Meckel's diverticulum was discovered and which was responsible for the symptoms. This figure varies from 20 to 35 per cent in other series.<sup>4,5,7</sup> In ours it is 42 per cent.

The age incidence in this series parallels that of other series. A notable finding in

relation to age incidence is that the percentage of patients showing a pathologic condition of the diverticulum is higher in the first two decades. Twenty-two of our cases occurred in the first two decades; fifteen of these, or 68 per cent showed

AGE INCIDENCE

Age (Years)	No.	No. Showing Pathologic Changes
Less than 2	5	3
2-10	8	6
11-20	9	4
21-30	13	5
31-40	7	0
41-50	3	1
51-60	5	2
Over 60	0	0
Totals	50	21

pathologic changes, whereas only nine, or 32 per cent, of twenty-eight cases occurring in patients after the second decade showed pathologic changes.

## CLASSIFICATION

Greenblatt's classification<sup>8</sup> of disorders of the omphalomesenteric duct is one of the most adequate and inclusive. We have modified it to a certain extent by removing the heterotopic cases from the tumor group and classifying them as a separate group in which we include cases of peptic ulcer which Greenblatt has classified separately. The revised classification follows:

1. Obstructive Group.....	11
(a) Intussusception.....	2
(b) Volvulus.....	4
(c) Bands and adhesions.....	3
(d) Contents of hernia.....	2
2. Diverticulitis Group.....	5
(a) Simple acute inflammation.....	3
(b) Acute with perforation and gangrene.....	0
(c) Chronic inflammation.....	1
3. Heterotopic Group.....	10
(a) Gastric mucosa.....	7
(1) with ulcer and hemorrhage.....	1
(2) with ulcer and perforation.....	4
(3) with ulceration.....	0
(4) without ulceration.....	2
(b) Other tissues.....	
(1) pancreas.....	2
(2) duodenum.....	0
(3) colon.....	1

4. Umbilical Group.....	0
(a) Fecal fistula.....	0
(b) Umbilical adenoma.....	0
5. Tumor Group.....	0
(a) Malignant.....	0
(b) Benign.....	0
6. Incidental Group.....	29

Figures in the right hand column show the number of cases in this series falling into each group. One of our own cases remains unclassified. None of the cases in our series fell into groups 4 and 5 or into 2(b).

**Obstructive Group.** Eleven of our cases are included in this group. (Table 1.) There were two cases of intussusception (cases 6 and 23). In both cases invaginated Meckel's diverticulum was the leading point of the intussusception. It is interesting that each of these diverticula contained a sizeable nodule of pancreatic tissue and these were the only cases in which pancreatic tissue was found. It seems possible that peristaltic movements of the diverticulum in attempting to expel its contents or an intrinsic mass could be responsible for invagination. Such a chain of events is suggested by Atwood in a recent paper.<sup>9</sup> Hunt and Bonesteel list four such cases in their compilation.<sup>11</sup> Ladd and Gross<sup>10</sup> report that of 372 cases of intussusception occurring in children fourteen were associated with Meckel's diverticulum. Another case of intussusception occurred in this series but there was no evidence that the diverticulum in this case was more than an incidental finding.

There were four cases of volvulus (Cases 1, 15, 20 and 33). In the last three a stalk was present running from the tip of the diverticulum to the inner surface of the abdominal wall in the region of the umbilicus about which loops of small bowel had become twisted. Figure 1 shows the diverticulum and stalk in Case 20. In case 15 the entire small intestine was twisted about the band. In Case 1 the volvulus involved a two-foot loop of terminal ileum. In the mid-point of this loop was an inflamed Meckel's diverticulum but it cannot be ascertained from the operative



FIG. 1. Meckel's diverticulum can be seen attached to the under surface of the umbilicus; x, umbilicus; A, B and C, Meckel's diverticulum; x—y, ileum.

note whether or not the diverticulum was an integral part of the disorder. (Figs. 2, 3 and 4.)

Disturbances as the result of bands and adhesions are illustrated by Cases 8, 24 and 25. Case 8 is of interest in that the patient showed signs of obstruction eight days after the removal of an acute appendix and operation showed a Meckel's diverticulum looped over the ileum and compressing it. Two other points of obstruction, the result of adhesions, were freed and the diverticulum was left in place because of the patient's poor condition. Three months later the patient returned to the hospital complaining of frequent crampy periumbilical pains with nausea and vomiting. An operation revealed distention above the point of origin of the diverticulum. Adhesions so distorted and kinked the ileum that obstruction had resulted. Resection of the loop bearing the diverticulum was then carried out. In the other two cases the position of the diverticulum so rolled and kinked the ileum that there was narrowing of the lumen at the point of origin with symptoms of intermittent partial obstruction.

In three cases a Meckel's diverticulum was found in a hernia. In one case it was an incidental finding but in Case 5 the pa-

tient had symptoms consistent with strangulation and a large, infarcted Meckel's diverticulum was the sole content of the hernial sac. In Case 43 an omphalocele was noted at birth and an operation carried out before the child was four hours old. It was found that adhesion of a Meckel's diverticulum to the wall of the cord prevented retraction of a loop of the ileum. The diverticulum was removed and the bowel restored.

*Diverticulitis Group.* Meckel's diverticulum is subject to inflammatory changes in much the same manner as the appendix but with this difference: The lumen and ostium of the diverticulum is usually greater than that of the appendix and obstructive types of inflammation are less frequent. Cases 16, 22 and 28 represent acute inflammation. Each had an abrupt, progressive history indistinguishable from appendicitis. One man had previously had his appendix removed and the diagnosis of acute diverticulitis of Meckel's diverticulum was made preoperatively. Chronic diverticulitis as a diagnosis is about as unsatisfactory as the diagnosis of chronic appendicitis. Case 27 showed pathologic changes consistent with this diagnosis. The patient had had the history and physical signs usually associated with acute appen-

TABLE I  
OBSTRUCTIVE GROUP

Case No.	Type of Adhesions	Age	Symptoms	Signs	Operative Findings	Pathologic Findings	Rx.
8	Intussusception	15	Periumbilical pain with nausea and vomiting	Right lower quadrant spasm and tenderness	Ileo-ileal intussusception with Meckel's leading	Venous infarction; pancreatic tissue	Loop with Meckel's diverticulum resected
23	Intussusception	5 mo.	Vomiting 24 hr.	Melenae, visible peristalsis	Ileocolic intussusception with Meckel's leading	Venous infarction; pancreatic tissue	Meckel's diverticulum resected
1	Volvulus	22	Lower abdominal cramps with nausea and vomiting 24 hr.	Right lower quadrant spasm and tenderness	Volvulus of 2 ft. loop of ileum with gangrene	Venous infarction	Loop resected
15	Volvulus	10	Periumbilical cramps with vomiting 2 days	Right lower quadrant and periumbilical tenderness and spasm	Entire small bowel formed volvulus about stalk of Meckel's	Tissue lost	Meckel's diverticulum resected
20	Volvulus	29	Periumbilical cramps and vomiting 24 hr.; attack 3 yr. before	Generalized spasm and tenderness; absent arisistalsis	Volvulus of terminal ileum about Meckel's and its stalk	Acute inflammation of Meckel's diverticulum	Meckel's diverticulum resected
33	Volvulus	9	Periumbilical pain and vomiting; 2 previous attacks	Right lower quadrant spasm and tenderness	Ileum twisted about band running from Meckel's to umbilicus	Chronic inflammation of Meckel's diverticulum	Meckel's diverticulum resected
8	Bands and adhesions	19	Periumbilical pain and vomiting 4 days; 2 previous operations	Negative	Bowel at base of Meckel's kinked and rolled on mesentery; lumen small	Peridiverticulitis of Meckel's diverticulum	Loop with Meckel's diverticulum resected
24	Bands and adhesions	26	Episodes of right lower quadrant pain and nausea 1 mo.	Right lower quadrant tenderness and spasm	Tip of Meckel's held down by fibrous band and ileum kinked	Meckel's diverticulum	Meckel's diverticulum resected
25	Bands and adhesions	27	Episodes of epigastric pain, obstipation and nausea 5 yr.	Tenderness and spasm to right of umbilicus	Arose from lateral aspect of ileum; ileum kinked and lumen narrowed	Meckel's diverticulum	Meckel's diverticulum and loop of ileum resected
5	Contents of hernia	54	Incarcerated hernia	Irreducible tender mass; inguinal region	Red swollen Meckel's sole contents of herniae sac	Venous infarction of Meckel's diverticulum	Meckel's diverticulum resected
43	Contents of omphalocele	3 hrs.	Omphalocele noted at birth	Omphalocele noted at birth	Meckel's adherent to wall of sac, prevented retraction of ilcum	Tissue lost	Meckel's diverticulum resected



FIG. 2. A plain film of the abdomen showing the presence of dilated loops of small intestine which led to the making of serial studies of the small intestine.

FIG. 3. Meckel's diverticulum is present at the constricted area. The roentgenologist believed that this represented a retroperitoneal tumor which was encroaching on the lumen of the terminal ileum. Note the dilatation of the proximal loop.

TABLE II  
DIVERTICULITIS  
Simple Acute Inflammation

Case No.	Age	Symptoms	Signs	Operative Findings	Pathologic Findings	Rx.
16	52	No history recorded	No history recorded	Red, angry Meckel's diverticulum 4.2 cm. by 1.2 cm.	Acute inflammation	Meckel's diverticulum resected
22	41	Previous appendectomy; severe right lower quadrant pain with nausea and vomiting 24 hr.	Spasm and tenderness in right lower quadrant; tender on right on rectal examination	Inflamed diverticulum Meckel's 4½ inches long	Acute inflammation	Meckel's diverticulum resected
28	9	Upper abdominal pain shifting to right lower quadrant 24 hr	Spasm and tenderness in right lower quadrant	Inflamed Meckel's diverticulum 1.5 cm. long	Acute inflammation	Meckel's diverticulum resected
Chronic Inflammation						
27	16	Right lower quadrant pain with nausea and vomiting 12 hr.	Spasm and tenderness in right lower quadrant; tender on right on rectal examination	Large Meckel's diverticulum packed with feces	Chronic inflammation	Meckel's diverticulum resected

dicitis. A Meckel's diverticulum was found to be solidly packed with hard fecal material. (Table II.)

**Heterotopic Group.** Gastric mucosa, jejunal, duodenal or colonic mucosa and pancreatic tissue may be found in Meckel's

55 per cent; 74 per cent of these patients were under the age of fifteen. No statistics are to be found which illustrate the percentage of those patients having gastric mucosa in a diverticulum who also have peptic ulceration. In addition to hemor-

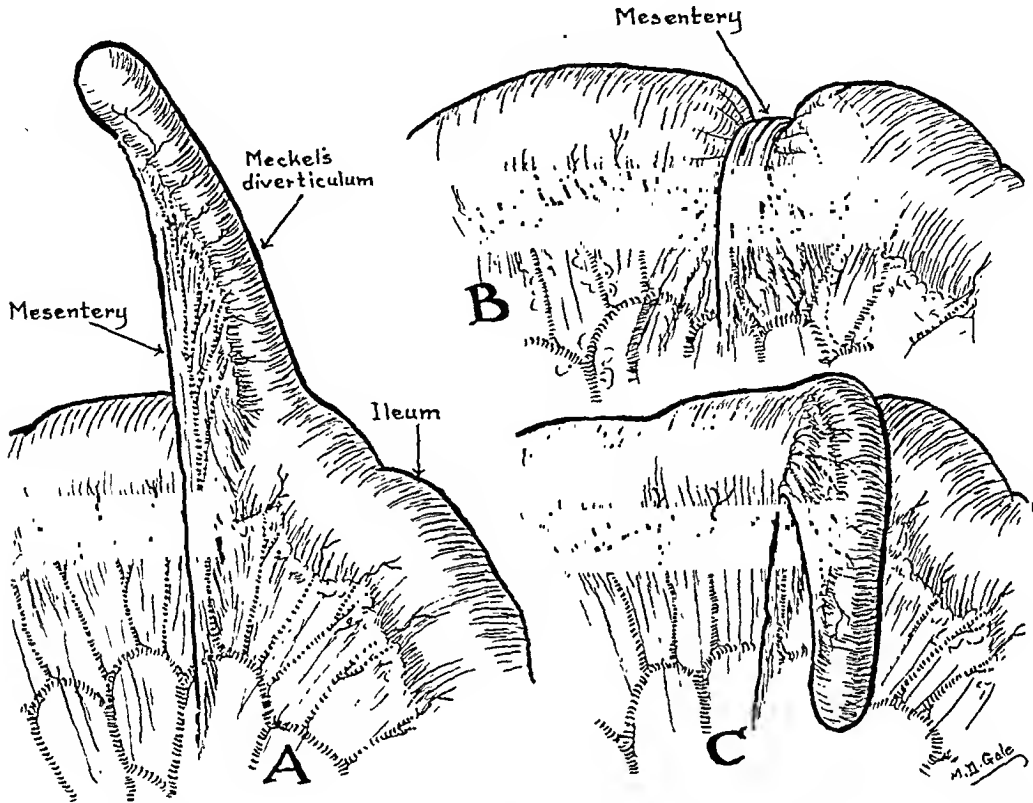


FIG. 4. A, Meckel's diverticulum hanging free in abdominal cavity; B, Meckel's diverticulum falling from the site of origin of its mesentery; note obstruction; C, Meckel's diverticulum falling toward side of origin of its mesentery; no obstruction.

diverticulum. Gastric mucosa is by far the most frequently found of those mentioned and is the only type consistently associated with symptoms. It is present in 16 per cent of all cases with Meckel's diverticulum according to Schaetz.<sup>2</sup> In children heterotopic gastric mucosa is the most frequent cause of symptoms; ulcer is the most frequent complication resulting from this disorder. Cobb<sup>2</sup> has reported a series of 110 cases showing ulceration in Meckel's diverticulum associated with the presence of gastric mucosa. The ulcer usually occurred in the immediately adjacent ileal mucosa, that is, near the base of the diverticulum. In Cobb's series hemorrhage occurred in 72 per cent and perforation in

rhage and ulceration a third complication is reported by Waugh et al.<sup>12</sup> These authors describe two patients in whom the scarring, resulting from the ulceration, so reduced the lumen of the adjacent bowel that obstruction resulted.

The mechanism of ulceration is discussed by Cobb<sup>2</sup> and may be briefly summarized: Acid secretion of the gastric mucosa of the diverticulum parallels that of the stomach; it, therefore, occurs at a time when the ileum lacks the protection of neutralizing food and secretions. Thus favorable conditions are found for ulceration.

Acute perforation, comparable to that which occurs in the stomach, is found in



TABLE III  
HETEROTOPIC

Case No.	Age	Symptoms	Signs	Operative Findings	Pathologic Findings	Rx
Gastric Mucosa with Ulcer and Hemorrhage						
48	8 mo.	Anemia and 2 episodes of melena	Pallor	Meckel's diverticulum 1.7 by 1.6 cm.	Ulcer on proximal edge of gastric mucosa lining diverticulum	Meckel's diverticulum resected
Gastric Mucosa with Ulcer and Perforation						
2	6	Right lower quadrant pain with vomiting, 1 day	Spasm and tenderness in right lower quadrant; tender on right on rectal examination	Free fluid perforation of Meckel's diverticulum	Meckel's diverticulum lined with gastric mucosa; perforated ulcer near base	Meckel's diverticulum resected
31	17	Crampy right lower quadrant pain spreading through abdomen 2 days, vomiting	Generalized spasm and tenderness; rectal tenderness	Free fluid; perforated ulcer of Meckel's; stalk ran to umbilicus	Meckel's diverticulum lined with gastric mucosa; perforated ulcer near base	Meckel's diverticulum resected
46	9	Generalized abdominal pain with vomiting 12 hr.	Generalized spasm and tenderness	Perforation at tip of Meckel's diverticulum; free fluid in abdomen	Meckel's diverticulum lined with gastric mucosa; ulcer at tip	Meckel's diverticulum resected
49	24	Upper abdominal cramps 8 days; right lower quadrant pain, 20 hr.; no nausea, vomiting	Generalized spasm and right lower quadrant tenderness	Free fluid in abdomen; perforation at base of Meckel's diverticulum	Gastric mucosa present; ulcer perforated at junction prox. and mid. $\frac{1}{3}$	Meckel's diverticulum resected
Gastric Mucosa without Uleeration						
14	10	Periumbilical pain with vomiting 48 hr.	Right lower quadrant spasm and tenderness	Appendix acutely inflamed; Meckel's diverticulum present	Acute appendicitis; Meckel's diverticulum contained gastric mucosa in diverticulum of its own	Meckel's diverticulum resected
17	21	Hirsutism	Hirsutism	Meckel's diverticulum found durexpl. laporotomy for casue of hirsutism	Gastric mucosa found in tip of Meckel's diverticulum	Meckel's diverticulum resected
Pancreas						
6	15	Periumbilical pain with nausea and vomiting	Right lower quadrant spasm and tenderness	Ileo-ileal intussusception with Meckel's diverticulum leading	Venous Infarection; pancreatic tissue	Loop with Meckel's diverticulum resected
23	5 mo.	Vomiting, 24 hr.	Melena, visible Peristalsis	Ileocolic intussusception with Meckel's diverticulum leading	Venous infarction; pancreatic tissue	Meckel's diverticulum resected
Colon						
32	12	Right lower quadrant pain and nausea, 12 hr.	Negative	Meckel's diverticulum 15 inches from ileocecal valve	Meckel's diverticulum lined with colonic mucosa	Meckel's diverticulum resected

Meckel's diverticulum usually in the growing child under eighteen. Perforation in the older age group is rare.

Gastric mucosa was present in seven of our cases and possibly in an eighth. (Table III.) In Cases 14 and 17 there was no associated ulceration; in both of these cases the diverticulum had given no symptoms and was an incidental finding. One patient, Case 48, had ulceration with bleeding and no perforation. This patient was an infant who was studied because of a severe blood-loss type of anemia. The condition was suspected and proved at operation. Four cases and possibly a fifth had gastric mucosa and peptic ulceration with perforation. These Cases are 2, 31, 46, 49 and 50. The last case cannot be included statistically, for the poor condition of the patient precluded removal of the diverticulum. A perforated ulcer was present, but the type of mucosa lining the diverticulum will not be known until a second operation is performed for the removal of the diverticulum. In none of the cases of perforation was there any clue as to the origin of the perforation preoperatively. The patients presented themselves with signs of perforation of a hollow viscus but with no signs which would localize the site of the perforation.

Nodules of pancreatic tissue were present in Meckel's diverticulum in our Cases 6 and 23. In both of these cases intussusception had occurred, with an invaginated diverticulum as the leading point. A casual relationship is suggested but cannot be proved.

Colon mucosa was present in the diverticulum in Case 32. In this instance the finding of Meckel's diverticulum was incidental to other conditions and had no relation to the patient's illness.

#### DIAGNOSIS

The diagnosis is rarely made preoperatively with any degree of certainty. Symptoms are as varied as the complications and are, in fact, the symptoms of the complications. Patients in whom obstruction

is the manifestation cannot be differentiated from those with obstruction due to other causes, nor can patients in whom perforation occurs be separated symptomatically from those with perforation of other hollow viscera. An exception might be made in the latter instance. Perforation of a Meckel's diverticulum has usually a less abrupt onset than perforation of a gastric or duodenal ulceration and is less likely to show the presence of air beneath the diaphragm. However, it cannot be distinguished from appendiceal perforation unless the appendix has been removed previously. In children peptic ulceration of Meckel's diverticulum is an important cause of intestinal bleeding, and such a diagnosis should be entertained in every case.

X-ray has little to offer diagnostically. According to Pfahler,<sup>13</sup> the diagnosis was not made by x-ray prior to 1934. However, since the advent of serial studies of the small bowel, the roentgenologists have on rare occasions been able to show the presence of residual barium in Meckel's diverticulum.

The cases in this series were reviewed with the intention of discovering any symptoms and signs which would lead one to suspect a diagnosis of Meckel's diverticulum. No specific diagnostic criteria were found.

#### TREATMENT

The treatment of choice is resection; an attempt should be made to take as wide a base as possible in an effort to remove all heterotopic tissue. This form of treatment was carried out in thirty-eight of our cases. In four cases the diverticulum was invaginated by simple purse-string sutures. Two criticisms of this procedure may be made: First, it creates a polypoid mass which may be the leading point of an intussusception although no such cases have been reported; second, it may leave heterotopic tissue. In eight of our cases the diverticulum was not removed. In four of these the process was extremely small; the serious condition of the remaining four

patients precluded any more manipulation than was absolutely necessary.

#### CONCLUSION

It has been the authors' experience that the incidence of Meckel's diverticulum has shown an increase paralleling the diligence with which it is sought. We note that the incidence in our series in which Meckel's diverticulum actually caused the patient's illness is considerably higher than the incidence in similar series. Perhaps the structure must literally cry for attention before we seek it. More careful search at operation may perhaps increase our percentage of "incidental" Meckel's diverticulum but at the same time prevent future illness. The authors were surprised to discover that only one case in their series was an infant with melena as the result of peptic ulceration. This may, perhaps, indicate some laxity in the study of children with recurrent attacks of abdominal pain. We believe that any child with frequent attacks of abdominal pain which have never been so severe as to bring him to operation should be studied for melena. Any patient whose operative findings fail to substantiate the preoperative clinical impressions should be considered as a prospective victim of Meckel's diverticulum.

#### SUMMARY

Fifty cases of Meckel's diverticulum are presented and analyzed. The literature is

consulted for comparison of this series with the series of other authors. The embryologic background is briefly given. The authors' experience in dealing with these patients is summarized and suggestions are made for improvement in diagnosis and treatment.

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# PERCUTANEOUS FIXATION OF HIP FRACTURES

CLAUSS B. STRAUCH, M.D.

*Hazel Green, Wisconsin*

**F**RACTURES of the hip, either through the major trochanter or the neck of the femur, occur frequently in older people. These fractures result in the highest mortality of any simple fracture of the long bones and even if the patient survives the result is often poor. Treatment of hip fractures is still a major problem.

Older people do not tolerate well prolonged immobilization which frequently causes intractable bedsores, pulmonary infections, thrombophlebitis and other complications and which, even with the best of care, is depressing and unbearable torture for many of them. In spite of these drawbacks treatment by extension or plastercasts is still used in a great majority of all hip fractures.

In the other extreme are treatments for hip fractures which require cutting surgical procedures, such as application of the Smith-Petersen nail, Moore pins, Lorenzo screws, Bohlman screw pins and related metallic or bony screws, pins, nails or brackets. These operations do away with prolonged immobilization but the necessary anesthesia, loss of blood and surgical shock are frequently too much for these older patients even if the procedure is performed quickly and efficiently.

In between the conservative and surgical methods lies application of screws or pins which are applied without cutting through the skin into the bone uniting the fragments. The idea of application of nails, screws, pins or wires through the trochanter into the neck for the purpose of uniting the fragments is an obvious one and not new. Von Langenbeck (1850), Koenig (1875) and Trendlenburg (1878) already described attempts in this direction. Nicolaysen of Oslo used a percutaneous nail in 1879, Schilling used a

square percutaneous nail in 1915, Neufeld described a percutaneous pin, Telson and Rauschoff used several percutaneous steel wires and Gaensler applied subcutaneous spikes. Doubtless in selected cases at present a great number of surgeons drill threaded or plain Steinmann pins into hip fractures through the skin.

The reason that the percutaneous use of pins in hip fractures is not accepted more widely lies chiefly in the technical difficulty of removing the excess length of the pin which extends from the bone through the soft tissues to the outside. It is possible, of course, to push back the skin and muscle to a considerable extent and to cut or file the pin off fairly deep and let the skin slip back. It is impossible, however, to cut the pins off short enough. An inch or more will still protrude from the bone, causing pain and preventing the patient from lying on the affected hip. After the muscles atrophy, as is usual in these fractures, the ends of the pins will protrude under the skin quite visibly and cause distress and possibly perforation.

A primitive method to facilitate removal of the proximal part of the pin consists in filing a deep circular groove around the pin approximately 4 inches from the tip and to break the proximal shaft off by bending it sideways after the pin has been properly applied. This is sometimes quite simple. We found, however, that the pin is loosened too much through bending when the bones are frail. Furthermore, it is difficult to bend the pin in stout or muscular patients. Lately such "break-off pins" have been developed which carry a bead.

Figure 1 shows an assembled new screw pin\* which the author designed for the

\*The author wishes to thank Edward Weck and Company, Inc., Brooklyn, N. Y. for their cooperation in manufacturing and supplying these pins.

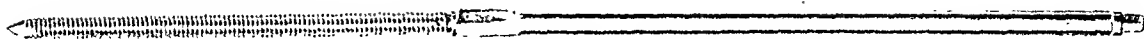


FIG. 1. Pin assembled.

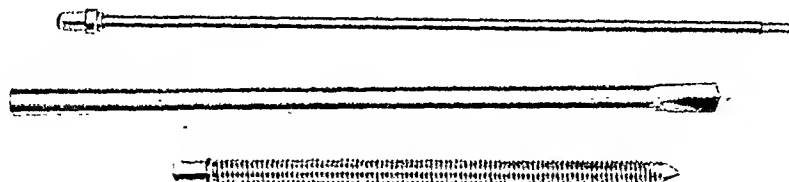


FIG. 2. Pin taken apart.

percutaneous fixation of hip fractures and Figure 2 shows the same pin taken apart. The assembled screw pin is driven into the fracture as deep as necessary. After the position has been found satisfactory the central wire is unscrewed permitting withdrawal of the drive shaft. In this way the screw can be driven into the bone without incision and the shaft can be removed with ease. Figure 3 shows an x-ray of a trans-trochanteric fracture immediately after application of the screw and withdrawal of the shaft. The same fracture which is healed four months later is illustrated in Figure 4. The screws are still in the bone and are healed well into their position. The patient, a man of seventy-six years of age, had no external fixation of any kind and walked on crutches six days after the accident. A total of twelve patients with hip fractures were treated at our hospital during the last eighteen months by these percutaneous screws with detachable drive-shafts with persistently good results.

It is best to have at least three sterile completely assembled detachable screw-pins of suitable lengths. In addition there should be a liberal supply of  $\frac{3}{16}$  of an inch Steinmann,  $\frac{3}{32}$  of an inch Granberry pins and some Kirchner wires to be inserted first for the purpose of orientation.

Sterile forceps should be ready for insertion of the pins or wire into the drill. Any surgical hand drill or a standard electric drill can be used; only the chuck need be sterilized.

Since the whole procedure is related more to a hypodermic puncture than to an operation, no elaborate aseptic precautions are necessary except, of course, painstaking protection of the asepsis of the screws and pins to be inserted. A pointed knife for making skin punctures and a few skin clips to close them complete the armamentarium. In stout patients it may be necessary to insert several pins or wires before hitting the proper plane. Repeated x-ray controls are necessary. We have, therefore, inserted these pins in the x-ray room either on the Bucky table for stout patients or without Bucky for those who are not as stout. In such instances it is practical to place under the injured hip a box easily made from two plywood sheets held apart on three sides by wooden strips and just large enough to accommodate the 8 by 10 cassette. In this way the film will always be in the same place and the patient does not have to be raised to place the cassette under the fracture side.

Careful reposition with x-ray control is, of course, the first necessary step. The



FIG. 3. Transtrochanteric fracture fresh after pinning.



FIG. 4. Same fracture as Figure 3 four months later.

anesthetic should be continued on a light plane; the leg is held in abduction and is rotated inwardly. The skin is carefully prepared and a Kirschner wire is drilled for orientation. If the wire will enter the bone on a steep angle, it will slide off easily and it is simpler to use Steinmann pins for guidance. The first pin may be fully off the intended direction; the second, third or fourth should give enough indication to place safely and accurately the final screws. These are driven assembled into the bone until the resistance by the slightly larger shaft is felt on the bone. After final control x-ray the guide pins and shafts of the screws are removed and the puncture holes are closed by skin clips. No external fixation should be necessary.

The patients can sit up soon after this procedure and they may be permitted to walk on crutches in selected instances. One of our patients, a seventy year old spinster of 105 pounds, was carried into our hospital shortly after she had sustained a complete fracture of the base of the neck of the

femur. One hour after admission a reposition was done with ether and two screws were inserted as has just been described. The same afternoon the patient was found walking in the corridor and she was discharged the next day since we could not keep her in bed. A week later she was visited at home and was found doing light chores. She stated at that time that she had been up and around all week and that she was not sure which hip she had broken. She was followed-up regularly and x-ray after four months showed the hip fracture to be well healed and in good position. This case is quite exceptional and shows the utmost contrast as compared with the torture of enforced immobilization in a cast or extension for three or four months.

The treatment of hip fractures by internal fixation and the indications therefor are well established and do not have to be digested here. The purpose of this paper is to describe the method of percutaneous pinning of hip fractures by a relatively minor, non-shocking procedure which re-

quires no cutting, no enforced immobilization and which can be done in a simple way by any general surgeon possessing patience and ordinary skill.

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BISHOP et al. studied the healing time of more than 350 bone grafts. Unsuccessful results occurred in about 10 per cent of the cases. Of the remainder the healing time varied. It averaged about twenty weeks for the dual type grafts, twenty-seven weeks for the average inlay graft and twenty weeks for the average onlay graft. Plates were often used in immobilizing these grafts thus permitting earlier ambulation. Healing time was the same, however, whether or not the plates were used. The authors prepared a bed for grafts by removing the outer two-thirds of the bony cortex. They resorted to this technic in the treatment of many cases of non-union of fractures of the long bones of the extremities, with good results. (Richard A. Leonardo, M.D.)

# TRANSITORY HYPOPROTEINEMIA IN ACUTE SEVERE FRACTURES\*

BERNARD J. FICARRA, M.D.

Assistant Visiting Surgeon, Kings County Hospital  
Brooklyn, New York

CURRENT literature abounds in physiochemical studies relative to clinical surgery. Few authors, however, have concerned themselves with the protein alterations in acute severe fractures. In view of this dearth of knowledge our

a low protein diet broke after less force was applied to them than did the bones of rats receiving a high protein diet.

Coincident with the early effects of acute trauma, a large output of nitrogen may occur in the urine. Taylor and associates

TABLE I

	Identifying Letters	Age and Sex	Injury	Duration of Injury (Hours)	Shock	Initial Protein Level	Uric Acid Level	Protein Level at Twelfth-hour Interval
1	E. S.	55, M	Compound lower $\frac{1}{2}$ left tibia-fibula	4	Absent	4.0	2	6.1
2	A. N.	50, M	Compound supracondylar left femur	3	Absent	4.5	1.5	6.3
3	R. G.	49, M	Lower $\frac{1}{2}$ right tibia and fibula	$3\frac{1}{2}$	Absent	4.2	1.5	6.5
4	F. C.	28, M	Middle $\frac{1}{4}$ left tibia and fibula	4	Absent	4.0	2.5	6.0
5	A. B.	35, M	Plateau and upper $\frac{1}{3}$ right tibia	$2\frac{1}{2}$	Absent	5.0	1.0	7.0
6	J. T.	54, M	Comminuted right tibia and fibula	3	Absent	4.0	2	6.8
7	M. C.	32, M	Comminuted lower $\frac{1}{3}$ femur	$4\frac{1}{2}$	Absent	4.5	1.5	6.5
8	T. A.	60, M	Compound middle $\frac{1}{3}$ left tibia and fibula	5	Absent	4.0	2.3	6.0
9	L. Mc.	29, M	Compound lower $\frac{1}{3}$ right tibia and fibula	4	Absent	4.5	1.5	6.2
10	A. T.	50, M	Comminuted upper $\frac{1}{3}$ right tibia and fibula	6	Absent	4.0	2.0	6.5
11	T. M.	25, M	Compound lower $\frac{1}{3}$ left tibia and fibula	5	Absent	4.0	1.0	6.0
12	D. M.	32, M	Compound subcondylar right femur	4	Absent	4.5	1.5	6.2

present efforts concerning the protein disturbance in patients with severe fractures appears significantly valuable.

Previous investigations by other authors focused attention on the possibility of protein depletion in trauma and fractures.<sup>1,2,3</sup> Cutlbertson found that nitrogen losses in the urine after fractures reached 25 Gm. daily. Howes and McKeown studied the healing of fractures in rats. They attributed delayed healing to hypoproteinemia. Bone fragility was also tested. They stated that the bones of rats receiving

maintained that a large part of this output may be in the form of "undetermined" non-protein nitrogen. They did not believe that this source of nitrogen loss, and hence protein depletion, should be attributed to substances such as urea which are usually found in the urine.

Our own studies (Table I) have led us to believe in a definite physiologic pattern which occurs following an acute severe fracture. The occurrence of a severe fracture with marked soft tissue damage or destruction is associated with a local loss of

\* From Fracture Service of Dr. John F. Rayercroft, Department of Surgery, Kings County Hospital, Brooklyn, N. Y.





FIGS. 1 to 4. Illustrative cases of the type of fractures studied in this survey.

protein. In addition there is protein loss in the urine as proven by others who have studied urinary nitrogen loss following trauma.<sup>3</sup> Both sources of protein loss occur prior to the onset of shock. The presence of hypoproteinemia facilitates and predis-

poses to the onset of shock.<sup>4</sup> For this reason all our cases have been studied prior to the onset of clinical shock.

This hypoproteinemia is believed to be transitory and of insufficient severity to stimulate endogenous protein metabolism

which is the body's mechanism of replenishing a protein deficit. In previous publications attention was brought to the so-called systemic response on the part of the body in order to correct marked hypoproteinemia.<sup>5,6,7</sup>

Hypoproteinemia of this type may be associated with a hyperuricemia which results from accelerated endogenous protein metabolism. In acute severe fractures the protein loss is not severe enough to stimulate this accelerated endogenous physiology. Hence it has been termed "transitory hypoproteinemia."

In our survey twelve patients (Table 1) with acute severe fractures were studied. (Figs. 1 to 5.) All of our patients were adult men, apparently in good health before the onset of their injury. Initial protein studies were made as soon as the patient was admitted to the hospital. If the patient was in shock or displayed any evidence of incipient shock, he was not a candidate for this study. Men with multiple injuries or marked blood loss were likewise not studied. All cases presented had solitary acute severe fractures. In view of the absence of shock, none of the patients studied received parenteral fluid or plasma before or after the fracture was treated. Hematocrit determinations were within normal limits before and after correction of the injury.

Laboratory determinations demonstrated a lowering of the total protein level. Uric acid studies were made at the same time that a protein level was determined. It was found that uric acid remained at a normal value. This indicated that there was no tendency to excessive endogenous protein metabolism. Multiple protein determinations made following injury at hourly intervals indicated that the protein level will return to normal in about twelve hours. During this twelve-hour period the fracture was treated and the patient ate a full meal. If the patient ate before the twelve-hour period, the protein level returned more quickly to normal. Hemoconcentration could not explain the uniform return of the



FIG. 5 Illustrative case of the type of fractures studied in this survey.

protein to normal levels because of the normal hematocrit values before and after the fractures were treated. These findings further substantiate the contention that this type of hypoproteinemia is transitory and mild in type. It is not sufficiently severe to demand rectification on the part of the body by stimulating endogenous protein metabolism.

Not one of the twelve patients studied went into shock following the return of the protein level to normal. This finding is consistent with the knowledge that hypoproteinemia increases the susceptibility to shock.<sup>4</sup> Our current study argues for the old dictum of correcting fractures as soon as possible, not only because a more satisfactory anatomic result may be obtained but also because, in view of the facts presented, shock can be prevented even in severe fractures. This present study corroborates the work of others who demonstrated protein loss following acute trauma.<sup>1,3</sup> In addition our observations emphasize the transitory nature of the hypoproteinemia and the facility with which it can be corrected.

## SUMMARY AND CONCLUSIONS

1. Twelve male patients with acute severe fractures were studied from a physiochemical viewpoint.

2. Shock was absent in all instances; hematocrit values were within normal limits before and after the fracture was treated.

3. All displayed hypoproteinemia without hyperuricemia.

4. The hypoproteinemia is attributed to local protein loss due to tissue destruction and excessive urinary nitrogen excretion.

5. The transitory nature of this hypoproteinemic state is emphasized since a normal protein level was obtained within twelve hours following the correction of the fracture.

6. Reduction of the fracture plus an adequate intake of exogenous protein are the rehabilitating factors in correcting hypoproteinemia.

7. This return to positive nitrogen balance is a cardinal factor in the prevention of shock following severe fractures.

8. In addition to anatomic reasons, the early treatment of fractures is advocated in order to re-establish the physiochemical harmony which may cause severe fracture complications.

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# Case Reports

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## REFLEX ANURIA

### ITS TREATMENT BY PROCAINE SYMPATHETIC BLOCK

JOHN M. MCGOWAN, M.D.  
*Boston, Massachusetts*

AND

DANIEL H. AUTRY, M.D.  
*Little Rock, Arkansas*

THIS work concerns a case of complete anuria and uremia believed to be due to spasm of the afferent arterioles of the glomeruli. Procaine anesthetic block of the sympathetic nerves to both kidneys was followed on two separate occasions by a sudden and dramatic outpouring of urine by both kidneys. It is reasonable to assume that when a large number of glomeruli in a kidney fail to function from any cause, the resulting metabolites may set up afferent impulses which are relayed to the sympathetic nervous system in such a way as to produce spasm in the afferent arterioles of the remaining glomeruli. Whether or not the anuria is due entirely or partially to spasm of the arterioles one would expect relief from a procaine block of the sympathetic nerves to the kidney.

The sympathetic nerve supply to the kidneys has been reported by White and Smithwick<sup>6</sup> as passing through the eleventh and twelfth thoracic sympathetic ganglia. According to Wright,<sup>7</sup> the sympathetic fibers come through all the dorsal ganglia from the sixth to the twelfth, inclusive. Peters<sup>4</sup> believes that vasoconstriction plays an important rôle in reflex anuria. Among the many causes that he has considered for this condition are: obstructing calculus of one ureter, trauma to the renal areas, perinephritic abscess and peritonitis. As early as 1922, an effort was made to combat renal vasoconstriction in reflex anuria by splanchnic procaine block. Peters credits Neuwirt with being the first to successfully treat such anuria by this means. Rubritius<sup>5</sup>

reported success with this measure in seven of eight cases. As an alternate procedure to splanchnic block a few writers have advocated spinal anesthesia. Peters reviews reports of Hayes and Paramore, and Cubitt<sup>1</sup> who have reported successful treatment by means of spinal anesthesia.

Decapsulation of the kidney has been used with varying results in cases of nephritis, non-obstructive anuria, post-eclamptic anuria and similar conditions in which the method was considered either a life saving measure or of definite value. Nichol<sup>3</sup> states that decapsulation breaks up the sympathetic connections between the cortex and the capsule and thus in reality is a partial sympathectomy.

#### TECHNIC

The method used to interrupt the sympathetic nerve supply to the kidneys consists of blocking the two lower thoracic and the two upper lumbar sympathetic ganglia with procaine according to the second method of Labat.<sup>2</sup> The patient is placed either lying flat on the abdomen or turned on the side opposite the one to be injected. Four wheels are made in the skin with procaine 3 cm. lateral to the spine. Two of these are placed in the dorsal region opposite the tenth and eleventh thoracic spines and two are placed in the lumbar region opposite the upper edge of the first and second lumbar spines. The needles used are size 8 to 10 cm. Each needle is inserted vertical to the skin to a depth of 3 to 4 cm. Here the transverse process is contacted. The needle is then passed above

the transverse process and slightly medial until it comes in contact with the vertebral body approximately 3 cm. further forward. A marker in the form of a small piece of rubber should be placed on the needle. When its tip contacts the transverse proc-

and aspirated. The needle should then be rotated 180 degrees and aspirated again. If no blood, spinal fluid or air is obtained, injection may be started.

Five cc. of 1½ per cent solution of procaine is injected into each needle. One

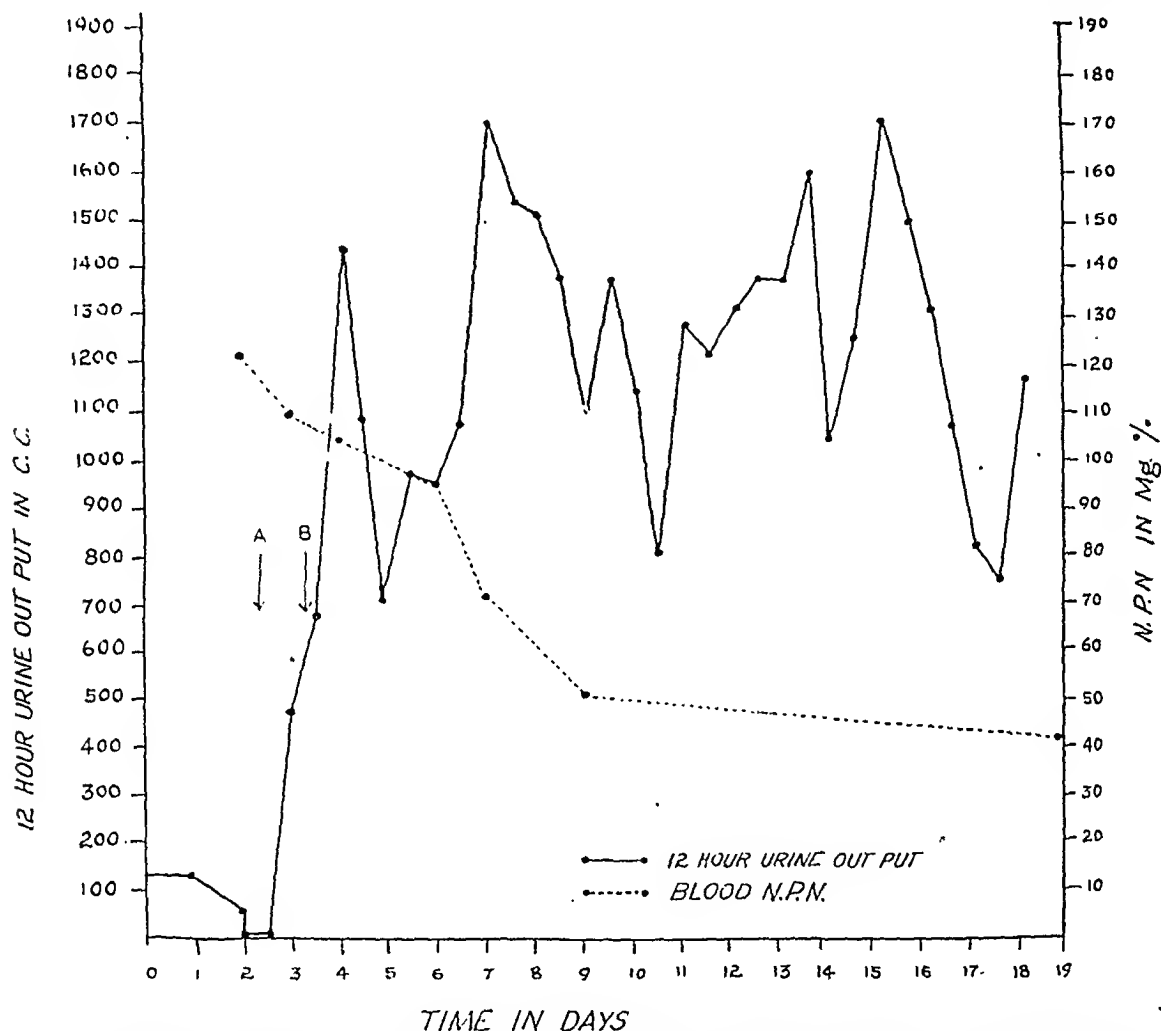


FIG. 1. This shows the urine output following procaine infiltration of the thoracic eleventh and twelfth and lumbar first and second sympathetic ganglia. The procedure was performed at A and again twenty-four hours later at B.

ess, this marker should be placed on the needle 3 cm. from the skin. The tip of the needle is pushed forward toward the body of the vertebra for a distance of 2.5 cm. to 3.5 cm. in front of the transverse process. The needle should not be attached to the syringe when it is being inserted. After it is put in place it should be examined very carefully to see that no spinal fluid or blood escapes. A syringe is then attached

should then wait for five minutes, at the end of which a further 5 cc. is injected. The legs are then tested for evidence of anesthesia. If any procaine enters the spinal canal through an anomalous extension of dura, evidence of this will be obtained by signs of anesthesia in the legs. If none is found, one may then inject a further 10 cc. in each needle. The same procedure is repeated on the opposite side.

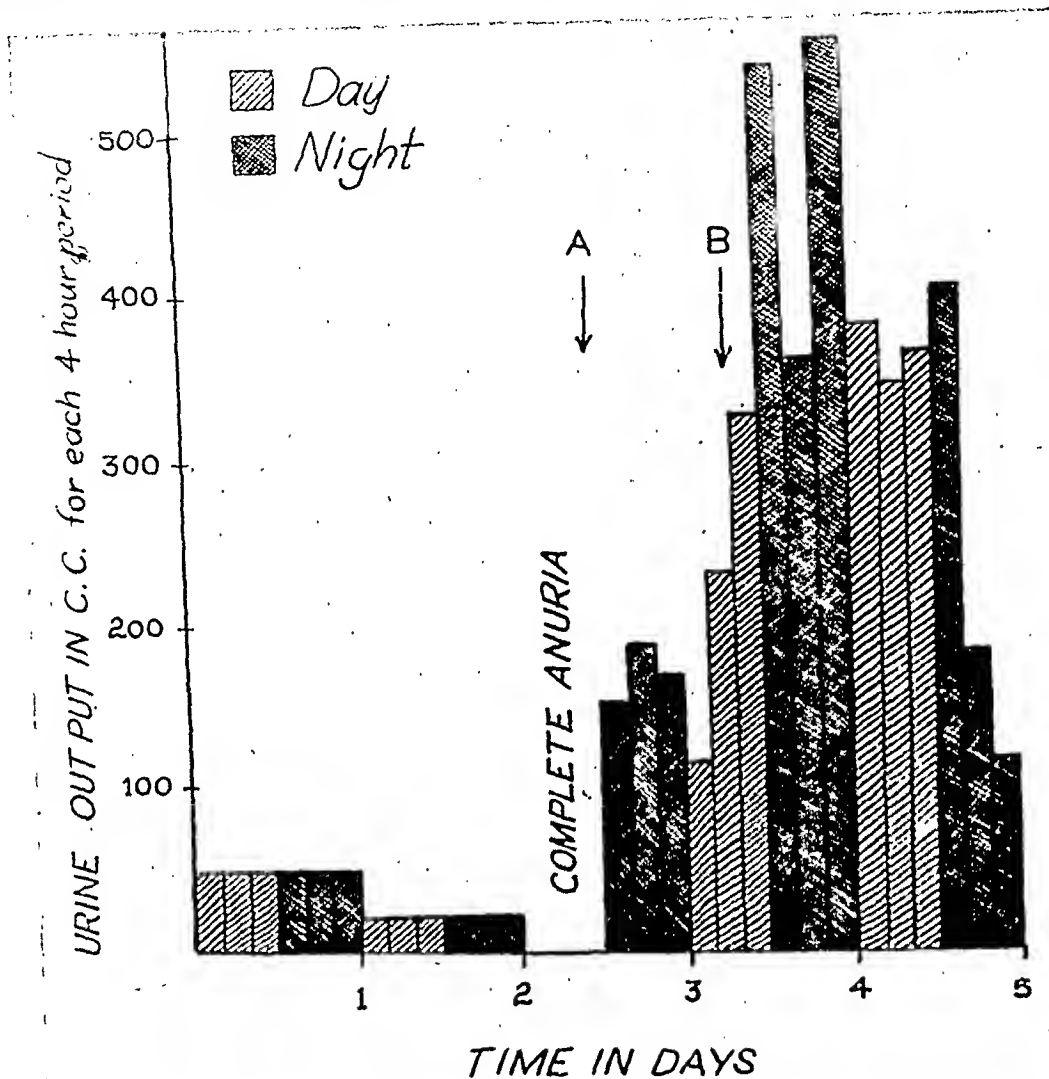


FIG. 2. This shows the response of the kidneys to sympathetic block at A and B. By showing the urine output in four-hour periods one can see more readily the response after each injection.

One must use care in order to prevent puncturing the pleura and so producing pneumothorax. This accident is prevented by keeping the point of the needle close to the body of the vertebra. The injection is done on both sides. The large quantity of procaine used enables one to infiltrate the splanchnic nerves as they pass downward in the lower part of the thorax and upper abdominal region. Also the nerve fibres around the renal artery are infiltrated.

#### RESULTS

The results were very gratifying. This patient had not passed very much urine for fifty-six hours. For the twelve hours

preceding the first treatment he had passed no urine. (Figs. 1 and 2.) Within an hour of the first sympathetic block, he was passing urine at the rate of 28 drops per minute. This rate continued for twelve hours during which time he passed a total of 480 cc. He continued to excrete urine for the next twelve hours at a reduced rate, finally reaching a level of only 7 drops per minute. The sympathetic block was then repeated with even better results. The urine flow promptly increased to 40 drops a minute. This continued for twelve hours during which time he passed a total of 1,445 cc. of urine. The urine flow continued at this rate for another twelve hours and

then settled down to a normal rate of flow. The blood non-protein nitrogen which had risen to 120 slowly decreased to a level of 50 mg. per cent. At the time of this report the patient's condition is excellent.

#### CASE REPORT

A white male, age nineteen, was admitted to Regional Hospital, Camp Joseph T. Robinson, Ark., on January 16, 1945. His chief complaints were malaise, chills and fever. He stated that he had had a cold since induction two months previously. He went on sick call the day prior to admission and was assigned to quarters because of malaise and fever. That night he felt increasingly worse and developed chills and fever. The following day he was admitted to the hospital. On admission he had considerable malaise and a mild cough which was slightly productive of yellowish sputum. There were no other symptoms except for moderate headache.

Physical examination on admission revealed a well developed and well nourished individual not appearing acutely ill. The temperature was 100°F., the pulse 88 and the respiration 20. The blood pressure was 118/80. The pharynx was congested but no membranes were seen. The tonsils were injected and moderately enlarged. Moderate bilateral cervical adenopathy was present. Examination of the chest revealed no abnormality of the heart or lungs. The abdomen was normal except for a healed incisional scar of the left upper quadrant. The remainder of the physical examination was essentially normal. The family history was non-contributory. His past personal history revealed that he had measles and mumps in childhood. He had recurrent attacks of acute tonsillitis four or five times in the past three years. The first attack was the most severe during which time he was in bed one week. No history of scarlatina, pneumonia, influenza, rheumatic fever, nephritis or other illnesses.

On admission to the hospital the patient was considered to have moderate nasopharyngitis and acute bronchitis. He was treated symptomatically with bed rest for two days after which he felt quite good and was permitted bathroom privileges. The temperature ranged from 98.6 to 99.8°F., for five days. On January 21st, the temperature rose to 103°F., pulse to 100 and respirations to 26, but they returned to normal limits by January 22nd. On January

24th, eight days after admission, his temperature again rose to 101.2°F. Examination of the lungs revealed diminished breath sounds and scattered fine crepitant râles at the right base posteriorly. X-ray of the chest on this date showed a pneumonic process in the right lower lobe which was considered to be an atypical pneumonia. The general appearance of the patient remained good. The temperature gradually returned to normal. Urinalysis on admission was normal, but on January 26th the microscopic examination showed 4 to 6 white blood cells and 8 to 10 red blood cells per high power field. On January 27th, urinalysis was again normal except for 2 or 3 red blood cells per high power field. On January 29th it was normal except for an occasional white blood cell. The total blood leukocyte count on January 26th was 12,500.

On February 3rd the patient had been afebrile for eight days. X-ray on this date showed considerable resolution of the pneumonic process in the right lower lobe. Because of a painful tooth of two days' duration, he was referred to the dental clinic where extraction of L 4 was performed. On the evening of February 6th, he complained of pain in the right side of his chest. The temperature was 102°F., pulse rate 120 and respirations 40.

On February 7th he was placed in an oxygen tent because of slight cyanosis and increased respiration rate. Physical examination at that time revealed evidence of a pathologic disorder at the right lower lung base with dullness on percussion, diminished breath sounds and numerous subcrepitant rales. Penicillin therapy was begun. On this date it was noted that no urine had been passed for the preceding twenty-four hours in spite of a total fluid intake of 4,320 cc. For this reason he was catheterized and only 270 cc. of dark red urine was obtained. An indwelling catheter was left in the bladder in order to follow more closely the kidney function. In the next twenty-four hours the output of urine was only 150 cc. in spite of an intake of 2,680 cc. Blood non-protein nitrogen was 120 mg. per cent. During the next twelve hours the patient put forth no urine at all despite adequate hydration. On February 8th physical examination indicated an extensive pleural effusion of the right side of the chest. This finding was corroborated by portable x-ray. Thoracentesis was performed and 1,020 cc. of turbid, straw-colored fluid was obtained

from the right pleural space. Penicillin, 40,000 units, was injected into the right pleural space. Smear and culture of the pleural effusion was later reported negative. Laboratory tests on this date revealed the following: Urinalysis: specific gravity, 1.023; acid reaction; albumin, 3+; sugar, negative; microscopic, innumerable red cells. The blood counts were: red blood cells, 4,100,000; white blood cells, 24,400. Differential: neutrophils, 87 per cent; lymphocytes, 13 per cent. Blood non-protein nitrogen, 126 mg. per cent. Alkalinization of the urine by sodium citrate was instituted. Penicillin was administered intramuscularly, 20,000 units every two hours. Clinically the patient appeared acutely ill. There was some hiccoughing which was considered secondary to nitrogenous retention. Blood chloride level was 440 mg. per cent.

In the evening of February 8th paravertebral sympathetic block was performed. The lower two thoracic and upper two lumbar ganglia were infiltrated with procaine 1½ per cent. Twenty cc. were injected at each site. Following the sympathetic block, urine output increased dramatically within two hours. During that night there was a total output of 480 cc. On the afternoon of February 9th, the urinary output again decreased to 7 drops per minute from the indwelling catheters. A sympathetic block was performed as before with even better results. Urine output suddenly increased to 40 drops per minute. During the next twelve hours there was a total output of 1,445 cc. The urine output continued at this rapid rate for another twelve hours and then decreased to a normal rate as indicated in the graphs. (Figs. 1 and 2). The next day the hiccoughing disappeared. Thereafter the patient had a stormy course but with gradual improvement. Intravenous fluids were used to supplement oral intake so that dehydration was never present. Thoracentesis was performed on February 10th when 1,000 cc. of turbid, straw-colored fluid was removed. On the same day, because of nausea, vomiting and distention, Wangensteen suction was instituted.

On February 26th, because of secondary anemia with red blood cell count of 2,850,000 and hemoglobin of 53 per cent, a transfusion of 500 cc. of citrated blood properly typed for hemologous grouping and Rh factor was administered, but was discontinued after 300 cc.

had been administered because of slight chills and nausea.

Thereafter, there was slow but progressive improvement in the general condition of the patient with the exception of continued albuminuria 1+ to 3+ with numerous red blood cells which gradually disappeared. The pathologic condition in the right lung rapidly disappeared.

#### COMMENTS

The large quantity of procaine injected to accomplish the sympathetic block in this case was used for two reasons. First, because smaller quantities had been unsuccessful in relieving a case of reflex anuria previously treated in this hospital. Secondly, because the innervation of the kidneys is believed to come from the lower six thoracic sympathetic ganglia, it was considered necessary to block the splanchnic nerves as they pass downward in the chest and abdominal cavities. The question arises as to whether or not this patient would have recovered without a sympathetic block. It is very probable that he would not have recovered since he was rapidly going down hill in a condition of uremia. The results were too sudden and dramatic to be an accident. By consulting the graph in Figure 2 one will note that the night output following sympathetic block on both occasions far exceeded that of the day. This is the reverse of what would naturally occur if the return of kidney function was spontaneous and not the result of the block. As it was the sympathetic block was performed in the afternoon and so the greatest output was immediately following.

This procedure will probably not benefit cases of anuria in which spasm of the arterioles is not a factor. Because the procedure is so safe and easy to apply in the very ill, it should be given a trial even when possibility of benefit is remote before submitting the patient to the more major procedure of decapsulation. Particularly is this so when the condition is of a critical nature.



If the first block does not produce benefit, it should be tried for two more occasions at twelve to twenty-four-hour intervals since we have found that in treating conditions due to a disturbance in the sympathetic nervous system each successive treatment up to the third is more beneficial than the one before. This patient was well hydrated at the beginning of the oliguria since he had received 4,320 cc. of fluid in the preceding twenty-four hours. After anuria became established the daily fluid intake was cut to 2,680 cc. in order to avoid overhydration. The increase in renal output was accomplished without increase in intake; however, after renal function was restored by novocain sympathetic block the fluid intake was increased.

#### SUMMARY

1. Reflex anuria due to a spasm of the arterioles of the glomeruli is believed to occur with retroperitoneal hemorrhage, injury to one or both kidneys or in cases

in which organic disease within the kidney actually exists.

2. A case is reported in which reflex anuria was relieved by blocking the sympathetic innervation to the kidneys with large quantities of procaine.

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# POLYPOSIS OF THE STOMACH TREATED BY TOTAL GASTRECTOMY

CHARLES A. STEINER, M.D.  
Diplomate, American Board of Surgery

AND LOUIS H. PALMER, M.D.  
Assistant Surgeon, Bryn Mawr Hospital  
Upper Darby, Pennsylvania

GASTRIC polyposis was first described as a disease entity by Cruveilhier<sup>4</sup> in 1833. Quain<sup>7</sup> in 1857 presented a case to the pathological society of London of a young girl who vomited a gastric polyp the size of a chestnut; this is believed to be the first such diagnosis made during the life of a patient. Chosrojeff<sup>3</sup> in 1912 is credited with having made the first clinical diagnosis from gastric lavage which contained particles of polypi. According to Balfour,<sup>1</sup> Carman in 1919 was the first to demonstrate the value of x-ray in the diagnosis of this condition, and Schindler<sup>8</sup> in 1922 is credited with the first gastroscopic diagnosis. Since that time with improving x-ray and gastroscopic technics, gastric polyposis has received increasing attention in the literature. Brunn and Pearl,<sup>2</sup> in a comprehensive review in 1926, were able to find only eighty-four proven cases of gastric polyposis to that date but were able to add forty-one more cases by 1943.

Isolated polyps of the stomach are not at all unusual; in fact, various authors estimate that about 1 per cent of all tumors of the stomach are of this type. The term polyposis has been arbitrarily applied to cases in which three or more polyps are present simultaneously in the stomach and although many classifications have been advocated there would appear to be two general types of polyps from a gross and microscopic point of view. A detailed description of the differences in the pathologic picture of these two types can be found in the work of Menetrier.<sup>6</sup> However, the salient features of each variety as described by him would seem to be as follows: The first type, "polyadenomes polypeaux," which consists of polyps that

have a slender stalk and head with normal gastric mucosa present between the polyps. Microscopically, this group is characterized by the presence of submucosa and muscularis extending out into the stalk. Cyst formation is common. The second type, "polyadenomes en nappe," is a slightly elevated growth having a sessile base resting on the submucosa. There is no differentiation into a head and stalk as in the first type and no normal gastric mucosa is present between the polyps. In fact, much of the gastric mucosa shows evidence of chronic gastritis either of the hypertrophic or atrophic type.

Polyposis of the stomach has been variously described as having been found in individuals ranging in age from twenty-three to eighty. Epigastric discomfort is usually the earliest complaint although at times vomiting, hematemesis, blood in the stools and diarrhea may be associated. The incidence of hypochlorhydria and even achlorhydria in polyposis of either type is extremely high, and it might be worth noting that polyposis of the stomach is present in many patients with pernicious anemia in whom chronic gastritis and achlorhydria are commonly found. Roentgenologically, the diagnosis may be extremely difficult and, in fact, Brunn and Pearl state that in their most recent series of forty-one cases only seventeen were diagnosed by x-ray. The most positive method of diagnosis is by gastroscopic visualization of the lesions.

In the 129 cases reported to 1943 three methods of treatment were described: (1) Gastrotomy with local excision of the polyps. (2) Subtotal gastrectomy consisting of resection of the polyp-bearing portion of the stomach if the polyps were

limited to a relatively small area. (3) In cases in which polyposis was present throughout the entire stomach subtotal gastrectomy was done, supplemented by local excision or fulguration of the polyps remaining in the cardiac end of the stomach.

It would appear that in cases in which extensive polyposis involves the greater portion of the stomach, particularly if associated with marked gastritis or when most of the polyps are situated in the cardiac end of the stomach, the aforementioned methods of treatment would be highly unsatisfactory. It would appear further that nothing short of total gastrectomy could offer such an individual a permanent cure, particularly since these polyps are regarded as precancerous lesions with actual malignancy being present in approximately 20 per cent of autopsy specimens.

We would like to present a case in which the polyps were scattered throughout the entire stomach, but were especially numerous in the cardiac portion, and in which moderate gastritis of the entire gastric mucosa existed. This patient was treated by total gastrectomy and although this procedure is being performed with increasing frequency for carcinoma of the stomach we have been unable to find any other case report in which gastrectomy has been performed for polyposis.

#### CASE REPORT

J. M., a white man aged sixty, was admitted to the Bryn Mawr Hospital October 14, 1945. This man had first consulted a physician in May, 1945, with the complaint that for several months he had noticed increasing fullness after meals, anorexia, belching and loss of energy and weight. His past medical history was irrelevant except for two factors: In 1916 he had been operated upon for acute appendicitis with perforation, following which he developed thrombophlebitis of the left leg with pulmonary embolus, and in 1937 an episode of jaundice occurred for which he was treated medically with no recurrence.

During the first few weeks under his physi-

cian's care numerous studies were carried out and were negative, with the following exceptions: An x-ray of the stomach on June 21, 1945, suggested polypoid change of the gastric mucosa; gastric analysis June 22, 1945, showed an achlorhydria and gastroscopic examination by Dr. Frederic Monaghan performed on June 28, 1945 revealed a generalized polyposis of the entire stomach but more especially in the mid- and cardiac portions.

It was believed that the lesion was so extensive that surgical removal of the entire stomach was indicated and a regimen consisting of high vitamin, high protein, and high caloric diet plus use of insulin was instituted in preparation for operation. By the time the patient was admitted to the hospital he had gained over 15 pounds in weight although his original symptoms continued unchanged.

Physical examination on admission revealed a rather pale, gaunt, apathetic man 6 feet tall, weighing 130 pounds. Other than a slight systolic apical murmur examination was essentially negative.

Laboratory examination revealed the following: red blood cells, 5,050,000; hemoglobin, 16.3 gm. or 101 per cent; white blood cells, 9,600; polymorphonuclears, 64 per cent; lymphocytes, 32 per cent; monocytes, 2 per cent; plasma cell, 1; basophiles, 1; urinalysis negative; Wassermann, negative; blood urea nitrogen, 12 mg. per cent; serum protein, 6.4 Gm.; albumin, 4.9 Gm.; globulin, 1.5 Gm.

Operation was performed on November 23, 1945. With continuous spinal novocain anesthesia and through an upper left rectus incision, exploration of the abdomen was carried out and no gross pathologic disorders could be detected. The stomach was of average size and there was some evident thickening of the anterior gastric wall in the cardiac portion. No definite polypi could be palpated through the gastric wall. In order to determine more accurately the extent of involvement of the stomach by polypi gastrotomy was done through which polypi of various sizes were seen to be present from the pylorus to the extreme cardiac end of the stomach, being more numerous at the latter end. Likewise at the cardiac end of the stomach there was evidence of a definite chronic inflammatory process involving the mucosa. It was believed, therefore, that nothing less than total gastrectomy could offer this patient a permanent cure. Therefore, this



FIG. 1. Specimen of entire stomach containing polypi throughout.

procedure was then carried out according to the method of Lahey,<sup>5</sup> the entire stomach being removed, the duodenum closed, the jejunum anastomosed side-to-end with the esophagus and a jejunojejunostomy performed. Ten Gm. of sulfanilamide were introduced into the abdomen and the abdomen was closed without drainage. The patient received approximately 1,000 cc. of plasma throughout the procedure and his condition at conclusion of the operation was good.

Pathologic report by Dr. Max Strumia disclosed the following: "A. *Gross Description:* The specimen consists of an entire stomach and greater omentum with a portion of the gastro-hepatic omentum. The stomach was opened along the greater curvature. Approximately twenty-five fairly discrete polyps are seen to rise from the mucosa a short distance from the cardiac orifice. Most of these are on the anterior and posterior wall adjacent to the lesser curvature. The polyps vary in diameter from 0.5 to 1.5 cm. Some are sessile, others are pedunculated.

"B. *Microscopic Description:* The gastric mucosa adjacent to the polyps shows moderate lymphocytic, eosinophilic and plasma cell infiltration. The cores of the polyps rise from

and include the submucosa which contains an increased number of dilated, blood filled veins. The mucosal covering of the polyps is not increased in thickness. The glands and gastric pits show marked distortion and frequent cyst formation. In some of the polyps the pattern of the glands is very atypical and the cells are hyperchromatic. This suggests malignant change, but there is no invasion beneath the muscularis mucosa so that a diagnosis of carcinoma is not justified." Note the entire stomach with polypi in the accompanying illustration.

During the first ten postoperative days the patient's temperature ranged from 99 to 101°F., pulse from 100 to 130 and respirations from 20 to 24. He received daily transfusions of plasma and whole blood for three days and subsequently at intervals of from two to three days to maintain a satisfactory blood count and serum protein level. Sulfadiazine and penicillin therapy were instituted on the day following operation and were maintained for approximately two weeks. He received nothing by mouth for three days at which time feedings were begun with 1 dram of tap water at hourly intervals. During the subsequent week his diet was increased to the point at which he was

receiving fourteen-hourly 3-ounce feedings of surgical liquids, gelatin, junkets and custards. Two weeks following operation white meat of chicken and puréed vegetables and fruits were added to his diet.

We have thought, as have many other surgeons, that early ambulation of patients post-operatively is an important measure in preventing thrombophlebitis, phlebothrombosis, pulmonary embolism, etc., particularly when an earlier history of one of these conditions is present. As just mentioned this man had had an episode of intravenous clotting with pulmonary embolism following an appendectomy in 1916, and for this reason he was gotten out of bed daily from his first operative day. In spite of this on his tenth postoperative day some edema of the left ankle and lower leg appeared although with compression bandaging and elevation of the extremity this was of a minimal degree and persisted only a few days.

The patient was discharged from the hospital on December 5, 1945, with the incision healed by primary intention; his rather long period of hospitalization can be explained by inadequate facilities for care at his own home. He was eating the equivalent of a soft diet with fair appetite and with no discomfort and his weight was 108 pounds.

Since December 5, 1945, the patient has continued to be free of symptoms, his weight has increased to 115 pounds, he has returned to his former occupation and his diet is now practically unlimited.

#### SUMMARY

1. Although only 125 cases of gastric polyposis have been reported prior to 1943, this condition is receiving increasing attention in the literature because of improving roentgenologic technic and use of the gastroscope.

2. It would appear that treatment up to the present time, which consisted of gastrotomy with excision of the polyps, subtotal gastrectomy or subtotal gastrectomy with fulgeration of the remaining polyps, has been inadequate in cases of extensive polyposis.

3. A case of extensive polyposis with associated gastritis of the entire stomach treated by total gastrectomy is reported.

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# LYMPHOBLASTIC SARCOMA OF THE SMALL INTESTINE WITH PRIMARY MANIFESTATIONS IN THE SKIN\*

JOHN P. WEST, M.D. AND MYRON WRIGHT, M.D.  
*New York, New York*

IN the patient whose case we are here reporting a lymphosarcoma developed in the skin of both feet approximately four and one-half months before there were symptoms caused by the primary tumor in the small intestine.

The records show that malignant lymphoid tumors developing in any part of the body may metastasize to the skin, but we have been unable to find detailed reports of cases in which cutaneous involvement became apparent prior to symptoms referable to the primary tumor.

## CASE REPORT

A forty-six year old man was admitted to St. Luke's Hospital November 1, 1945, for treatment of circumscribed ulcerated tumors of both feet, of ten weeks' duration. The first symptom had been a mild burning sensation in both lower extremities. Two weeks after onset, red splotches appeared in the skin of the dorsum of both feet and within four weeks the reddened areas became ulcerated. At the time of admission to the hospital, there was extensive involvement of the soft tissues of the left foot by a fungoid tumor. (Fig. 1.) The lesion of the right lower extremity was limited to a single ulcerated tumor, approximately 4 cm. in diameter, in the skin of the dorsum of the foot. The patient had no complaints except those related to the lesions of the feet. He appeared to be in good health and physical examination was essentially non-contributory, except for the above mentioned tumors, a right inguinal hernia and deafness following meningitis. His temperature, blood count and sedimentation rate were within normal limits. Serologic tests for syphilis were negative. Roentgenograms revealed no bone involvement of the lower extremities and the chest was normal.

A biopsy specimen was taken from the tumor of the left foot. Microscopic examination of the biopsied material (Figs. 2 and 3) revealed an edematous area of skin invaded by a small

celled neoplasm. The tumor was composed of irregular cells varying in size from  $19\ \mu$  to  $24\ \mu$  with poorly defined cell borders and pale homogeneous eosinophilic cytoplasm. Large, oval or reniform nuclei occupied an eccentric position within the cells. The nuclear mem-



FIG. 1. Metastatic lymphosarcoma of the left foot on admission.

brane appeared thin and distinct. The nucleoplasm stained lightly, and the contained chromatin formed a fine, powdery network with numerous small points of condensation. A single prominent nucleolus was usually present. Mitotic figures were abundant in all portions of the tissue. Associated with the above cells there were numerous nucleated erythrocytes, eosinophils and occasional mature lymphocytes. Silver impregnation (-I-) showed fairly well developed argentophilic reticular fibers between the cells. In a few instances the

\* From the Departments of Surgery and Pathology, St. Luke's Hospital, New York, N.Y.

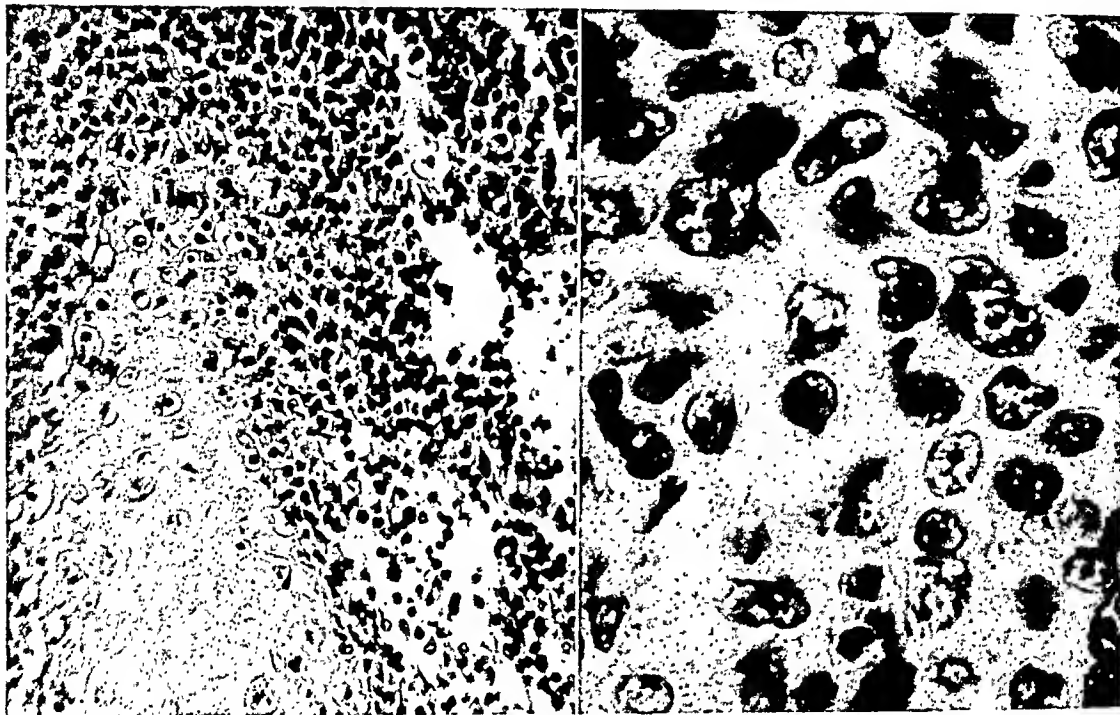


FIG. 2. ( $\times 1875$ ) Photomicrograph of material removed at biopsy of left foot showing edematous skin infiltrated by lymphosarcoma.

FIG. 3. ( $\times 1250$ ) Photomicrograph showing large lymphoid cells in skin of left foot.

fibers passed through cells resembling those of the tumor but were probably hyperplastic reticulocytes.

A short course of roentgen therapy, totaling 1,500 r. units to the right and 840 r. units to the

uncomplicated and the patient left the hospital thirteen days after operation.

On January 19, 1946, six weeks after amputation and four and one-half months after the development of the skin lesions, the patient was readmitted to the hospital because of epigastric pain, nausea and vomiting. These symptoms subsided rapidly and roentgenograms of the stomach, duodenum and colon disclosed no abnormalities. Small bowel studies were not made.

On March 8, 1946, the patient experienced a second attack of severe abdominal pain and returned to the hospital in critical condition. There was marked abdominal distention and palpation disclosed diffuse tenderness. Roentgen studies showed distention of the small intestine. Celiotomy revealed a diffuse thickening in the mid-jejunum through which a 4 cm. circular perforation had occurred. (Fig. 4.) The involved segment of bowel was resected and intestinal continuity reestablished by end-to-end anastomosis.

The postoperative course was satisfactory for one week when the patient began to complain of anorexia and abdominal pain. The temperature varied from 99 to 101°F., while the

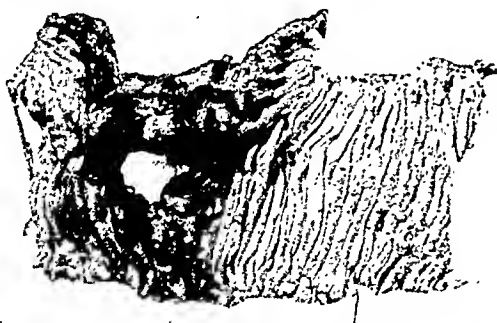


FIG. 4. Primary lymphosarcoma of the intestine with perforation removed at operation.

left foot, caused the tumor of the right to disappear and the tumor of the left to decrease in size. Obviously the cells were very radiosensitive. On December 4, 1945, thirty-four days after admission, the left leg was amputated above the knee because of the hopeless condition of the foot with its advancing and extensive gangrene. The postoperative course was



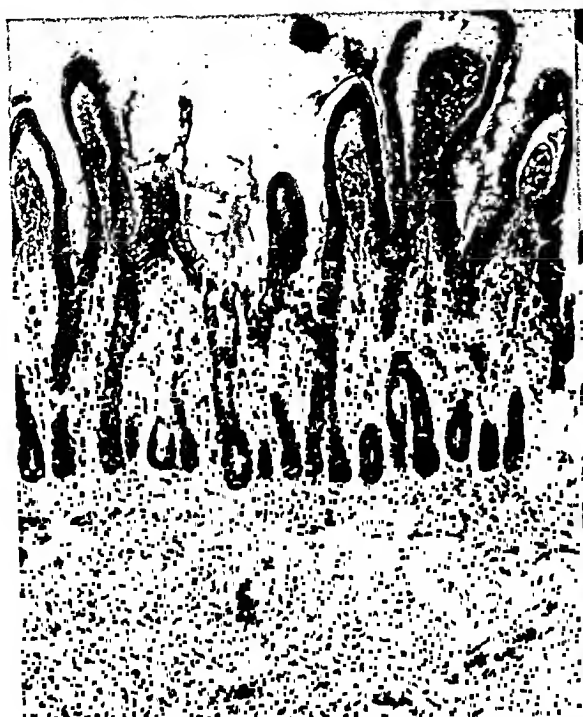


FIG. 5. ( $\times 75$ ) Photomicrograph of the jejunum showing infiltration by lymphosarcoma.

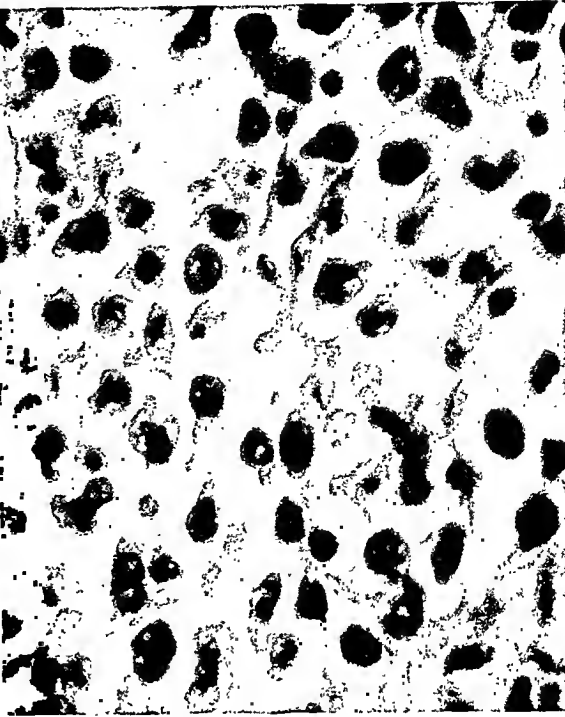


FIG. 6. ( $\times 875$ ) Photomicrograph of a portion of omentum showing lymphoid character of tumor cells.

white blood count showed only a slight elevation with normal distribution of cell types. On rectal examination a firm, non-tender mass could be felt. These symptoms continued for four weeks when a second jejunal perforation occurred. This was treated by another resection. The patient failed rapidly and died two days after operation.

Postmortem examination revealed generalized peritonitis and a third perforation which had occurred in a soft, white, non-constricting tumor mass located 6 cm. above the second anastomosis in the jejunum. The wall of the sigmoid colon was found to be involved by a similar tumor. The stomach, duodenum, ileum, ascending, transverse and descending colon, lung and liver were free of tumor. The mesentery of the jejunum contained numerous soft, white tumor masses and the retroperitoneal lymph nodes appeared to be extensively involved by infiltrating tumor. The spleen weighed 275 Gm. Section of the spleen revealed numerous soft, whitish masses varying in diameter from 1 to 2 cm. Microscopic examination of the jejunal (Figs. 5 and 6) and other abdominal tumors revealed tumor cells which were identical in all respects to those observed in the biopsied specimen from the foot.

#### COMMENT

The primary tumor in the intestine has the microscopic morphology of a large cell lymphosarcoma of lymphoblastoma, as some prefer. The character of the tumors in the feet is somewhat less clear but the chief element is certainly of lymphocytic type. Certain cells show a close relationship to the argentophil fibers but they are probably connective tissue cells from the neighboring inflamed tissues and do not necessitate altering the diagnosis of lymphosarcoma.

It is generally believed that lymphosarcoma does not develop as a primary cutaneous tumor<sup>2</sup> and the bilateral involvement of the skin of the feet in this case is evidence of a metastatic rather than primary tumor. Although skin lesions developed four and one-half months prior to any intestinal symptoms, it is evident that this tumor originated in the lymphoid tissues of the jejunum. As both of the extremities were involved at practically the same time it is apparent that the metastatic cells



must have entered the circulation above the bifurcation of the aorta.

#### GENERAL CONSIDERATIONS

The exact classification of the lymphoid group of tumors is not yet settled. Transitional types certainly occur. Gall and Mallory<sup>3</sup> proposed the following classification and nomenclature: stem cell lymphoma, clasmatocytic lymphoma, lymphoblastic lymphoma and lymphocytic lymphoma. These four groups represent a further subdivision of Ewing's older classifications and, as Gall and Mallory point out, they present a fairly satisfactory working basis for the classification of malignant lymphomas.

*Malignant Lymphoid Tumors of the Intestine.* Malignant lymphoid tumors of the intestine are relatively infrequent. Graves,<sup>4</sup> in 1919, collected 249 cases, and in 1932 Ullmand and Abeshouse<sup>5</sup> added 126 cases, bringing the total of reported cases to 375. The incidence of lymphoid tumors in malignancy of the entire intestinal tract is given by McSwain and Beal<sup>6</sup> in their report from The New York Hospital as 1.9 per cent. Warren and Lulenski<sup>7</sup> report an incidence of 0.9 per cent and Frygole, Kiernan and Docherty<sup>8</sup> state that approximately 1 per cent of all malignant tumors of the gastrointestinal tract, seen at the Mayo Clinic, are lymphoblastomas. Sugarbaker and Craver,<sup>9</sup> in reviewing 196 cases of lymphosarcoma seen at the Memorial Hospital, found that the primary lesions appeared in the gastrointestinal tract in thirty-one, or 16 per cent. Warthin,<sup>10</sup> in reporting 134 cases of lymphosarcoma, states that the primary tumor was in the intestinal tract in twenty-six, or 19 per cent.

*Malignant Lymphoid Tumors of the Skin.* Ewing<sup>11</sup> believed that lymphosarcoma of the skin occurs only as a metastatic process from other regions and stated that cutaneous lesions might appear early or late in the disease. On the other hand, Warren and Lulenski<sup>7</sup> state that, "Lymphoid tu-

mors of the skin, without evidence of lymph node involvement, have long been recognized and often classified under the broad description of 'Mycosis Fungoides.' These tumors may be the first manifestation and sole evidence of disease for many years. The majority of patients that come to autopsy have similar tumors involving either lymph nodes or other organs." Reported cases of skin metastases from intestinal lymphosarcoma are rare despite the fact that Gates<sup>12</sup> has reported 9 per cent cutaneous involvement in patients dying from malignant lymphoid tumors, and Sugarbaker and Craver<sup>9</sup> found the incidence of skin metastases in their 196 cases of lymphosarcoma to be 5.5 per cent. Neither of these reports indicate how many, if any, of these tumors manifested themselves primarily by cutaneous involvement.

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# HODGKIN'S DISEASE OF THE STOMACH

RALPH BERG, M.D.

*St. Louis, Missouri*

**H**ODGKIN'S disease limited to the stomach is of sufficient rarity and surgical interest to warrant recording. The following case is of particular value because the writer has had the opportunity of making yearly examinations of the patient for the past thirteen years due to the fact that annual examinations and Kahn tests are required of barbers in this state. The patient is now seventy-one years of age and is still active at his trade. Except for occasional episodes of mild cardiac decompensation, which respond to digitalis and rest, he enjoys good health.

## CASE REPORT

Mr. A. O., age fifty-eight, entered Lutheran Hospital on July 26, 1933. The patient stated that he felt well up to three months before admission. At that time he noticed pain in the upper abdomen. This pain would come in attacks; with each attack he would break out into a sweat and the pain would radiate throughout the entire abdomen. There was a weight loss of 10 pounds in these three months. During this time he noticed tar-colored stools on several occasions. His past history and family history were irrelevant.

The patient was well developed, pale and was not acutely ill. The heart rate was 76 per minute with each fifth beat followed by a dropped beat. The blood pressure was 130/85. The abdomen contained a large fixed mass in the epigastrium, extending about 4 inches to each side of the midline and downward nearly to the umbilicus.

Laboratory examination revealed the following: Red blood cells numbered 2,740,000; hemoglobin was 60 per cent; white blood cells numbered 9,000. The differential count was: juveniles, 4 per cent; stabs, 12 per cent; segmented, 65 per cent; lymphocytes, 15 per cent; monocytes, 4 per cent. Red blood cells showed slight poikilo and anisocytosis. Many basophilic stippled cells were seen. The red blood

cells had a pale appearance. Urine examination showed albumin, one plus. A few finely granular casts were found.

Gastrointestinal examination by x-ray showed a very large ulcer of the lesser curvature of the stomach, probably a carcinoma.

The laboratory report by Dr. W. Siebert follows: "The frozen section made at the time of the operation shows extensive infiltration of the stomach mucosa, muscularis, serosa and peristomach fat tissue with masses of individual cells which are closely packed and resemble reticulum cells. Scattered between these are typical plasma cells and eosinophiles. There is considerable erosion and ulceration of the stomach mucosa. The lesion apparently arises from the mucosa and is extending through the connective tissue between the muscle bundles. A few definite but somewhat atypical Dorothy Reed cells are seen scattered throughout the tissue. The paraffin section shows typical Hodgkin's granuloma."

The operation was performed on July 27, 1933, by Dr. R. Berg and Dr. C. F. Sherwin. The abdomen was opened through a left rectus incision. The muscle was retracted laterally. Palpation of the stomach region revealed a firm area on the lesser curvature adherent to the liver. No glands or liver metastases were palpable. On dissecting the adherent area of the stomach from the liver, a perforation occurred with the escape of gastric contents. The ulcer was then inspected from within and was found to have a sharply circumscribed margin which extended outward for a distance of about 4 cm. from the perforated area. This entire section was excised in a V-shaped (Fig. 1) manner and the stomach was closed first with a row of sutures from within, then with a Lembert suture from without. Vessels were ligated individually. One drain was placed into the lesser peritoneal cavity and one to the site of the ulcer. The abdomen was closed in layers; the patient was given two transfusions post-operatively. He had a temperature of 102°F. for two days; it then ranged from 99° to 101°F.,



FIG. 1. Excision of an ulcer on or near the lesser curvature of the stomach. The clamps are applied to include the ulcer which is excised after separation of the gastrohepatic omentum. In the small figure the first stitch is shown. (Courtesy of W. B. Saunders Company—Taken from "Abdominal Operations" by Moynihan.)

for ten days. The patient was discharged on the twenty-fourth postoperative day with two granulating areas still in the wound.

#### COMMENT

Attention was first drawn to gastrointestinal lymphogranulomatosis by the writings of Schlagenhauser,<sup>1</sup> Terplan,<sup>2</sup> Sternberg<sup>3</sup> and Coronini.<sup>4</sup> Gastrointestinal involvement in Hodgkin's disease may be primary, as in the case here reported, or the involvement may be part of a generalized Hodgkin's disease. The frequency of primary gastric involvement may be judged by the figures of Jackson,<sup>5</sup> who made a careful review of 174 cases of Hodgkin's disease and noted three of this group to be primary in the stomach. This author pointed out the important fact that such lesions may be asymptomatic for some time and finally a fatal rupture of such a lesion may occur. Apparently the lesion in our patient was asymptomatic until it approached the serosa.

The gross appearance of the stomach

lesions in the reported cases is very similar, namely, a soft flat infiltrating tumor associated with soft lymph nodes in the mesentery. This, according to Singer,<sup>6</sup> should arouse suspicion of Hodgkin's disease. The infiltration may either ulcerate or the cells in the submucosa may grow rapidly and result in the hyperplastic, firm type which is difficult to differentiate grossly from carcinoma. The microscopic appearance is that of a hyperplasia of the lymphoid reticulum in the submucosa; it is in this tissue that the plasma cells, eosinophiles and Dorothy Reed cells are found.

Clinically, the symptoms resemble those of carcinoma, that is, epigastric pain, eructation of gas, hematemesis, melena, loss in weight and strength are noted in both conditions. Rarely, as in our case, is a mass felt. The duration of symptoms is, for the most part, short; it is a matter of only a few weeks as in the case reported by Sherman,<sup>7</sup> three months in the case herein reported. In a case reported by Singer,<sup>6</sup> relief of pain was obtained for several

months by a Sippy diet. The laboratory and x-ray findings are also similar to those of carcinoma. A secondary anemia is usually found. The white blood count is usually low; rarely is an eosinophilia noted. Koenig<sup>8</sup> and Culver, in 1941, reviewed the literature on intestinal Hodgkin's disease and reported three new cases with particular reference to x-ray findings and concluded that there were no roentgen differences between Hodgkin's disease and other infiltrative, ulcerative lesions of the stomach. Jungmann<sup>9</sup> and others, however, have pointed out that in spite of the degree and extent of stomach involvement, peristalsis can still be seen in the stomach on x-ray examination and believed that this might be used to distinguish Hodgkin's disease from carcinoma.

From a review of the reported cases one concludes that the best plan of treatment is resection of the lesion either with or without postoperative x-ray therapy. The first case of successful resection was reported by Steindl<sup>10</sup> in 1924. When surgery can not be done, roentgen therapy may be used to lessen the severity of the symptoms.

#### CONCLUSIONS

1. A case of Hodgkin's disease limited to the stomach is reported. The patient is active thirteen years after resection of the lesion.
2. All masses or indurated ulcers of the stomach are not cancerous. Hodgkin's disease should be considered in differential diagnosis.
3. Resection of the lesion gives a good chance of cure.

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# SPONTANEOUS HEALING OF AN EXTERNAL BILIARY FISTULA

CARLO SAVINI, M.D.

*New York, New York*

**F**ISTULAS of gallbladders or of the biliary ducts are divided into internal and external fistulas. In internal biliary fistulas the fistular tract unites the gallbladder or a biliary duct to an internal abdominal organ. There are fistulas connecting the biliary tract to any portion of the gastrointestinal canal, to the kidney, to the urinary bladder or to the uterus. There are also reported cases of fistulas between the choledochus and the portal vein.

In the external fistulas the biliary ducts are connected with the external surface of the abdominal walls. Internal fistulas are due to adhesions and ulcerations of the two viscera and are found in about 5 per cent of all patients who are to be operated upon for diseases of the biliary tract.

The frequency of internal fistulas has remained unchanged but the external fistulas, generally the sequel of abdominal operations, are not found now so frequently as before in consequence of the progress and improvement in the operative technic obtained in recent years. While Louis Courvoisier was able, in 1890, to collect and classify 169 observations of external biliary fistulas, probably today there are surgeons who never have seen a single case of external biliary fistula consecutive to operation on the biliary tract.

External biliary fistulas very rarely heal spontaneously but generally require an operation. The operation consists in changing the external fistula into an internal one by connecting the fistular tract to the stomach or another part of the intestinal tract. Since such an operation is always difficult and often unsuccessful, I think it may be of interest to report a case of spontaneous healing of an external biliary fistula and see if we can explain what the conditions

are that favor such a rare and fortunate event.

## CASE REPORT

On June 13, 1938, a female patient, single, aged thirty-eight years, was admitted to the author's service at Columbus Hospital with the diagnosis of acute calculous cholecystitis. On June 30th, she was operated upon by the writer; cholecystostomy was performed numerous calculi were removed and the gallbladder was drained.

On August 3, 1938, the patient was discharged from the hospital in an improved condition. For a few months after the author had occasion to examine the patient frequently and he found her wound apparently perfectly healed. For many years he had no occasion to see or hear of the patient, but almost eight years later, on April 5, 1946, the patient was readmitted to Columbus Hospital affected with abscess of the liver. She was operated upon on April 17th with incision and drainage of a large abscess of the left lobe of the liver. On June 26, 1946, the patient was discharged from the hospital affected with an external biliary fistula.

After leaving the hospital and for more than three months there was a continuous leakage of bile from the fistular opening, at times in such a quantity as to seem a real outpouring. However, her general condition was good and the stools always contained bile.

She was treated at home by the writer up until October, 1946, when having seen no healing he decided that it would be necessary to operate, to dissect the fistular tract and connect it to the gastrointestinal canal. She was readmitted to the hospital on October 9th. It was intended that we should keep her under observation for a few days to prepare her for operation. The day after admission we were surprised to find that the fistular opening was closed. She was discharged from the hospital on October 16th apparently healed. The fistular opening remained closed and after a few days of rest, the patient's condition was so that good

she was able to resume her work in the factory where she had been employed and to take care of her household duties. She is perfectly well now.

In the literature of external biliary fistulas there are reported cases of healing of such fistulas without operation after treatment with vitamin K, with curetting of fistular sinuses and with the use of ultra-violet rays, but in this case the only treatment applied to the fistula was the ordinary dressings to keep the surroundings of the fistular opening clean.

With repeated x-ray examinations, we found that no calculus was present in the fistular tract or in its vicinity and by frequent inspection we always made sure that bile was passing into the intestinal canal, that the stools always showed the presence of bile and we trusted that with its

natural coarctation and narrowing the fistular tract would in the end close.

In conclusion it should be stressed that although the greater number of external biliary fistulas require a surgical operation, a small number of them can heal spontaneously without any operation. The most important sign that a spontaneous healing could possibly be expected is if some bile enters in the intestinal tract and is revealed by examination of the stools. When no calculus is seen and the presence of bile is demonstrated in the stools, it is worth while for the patient to wait and for the surgeon to delay operation for a reasonable time. If spontaneous healing occurs, the patient will be amply rewarded for the inconveniences resulting from enduring the fistula a few weeks longer.



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# New Instruments

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## METACARPAL FRACTURES

### MODIFICATION OF A NEW INSTRUMENT FOR THE MAINTENANCE OF POSITION AFTER REDUCTION

DAVID GOLDBERG, M.D.

*Springfield, Massachusetts*

THE writer has recently described a new instrument for the treatment of metacarpal fractures.<sup>1</sup> This instrument was devised for the simple transverse fractures involving the lateral four metacarpal bones and uses the principle of pressure pads to maintain position of the fragments after closed reduction.

Essentially this method of treatment, in part, was based on the principle originally advocated by Jahss<sup>2</sup> in so far that it uses the flexed proximal phalanx to push upward on the small distal fragment. Unlike the principle of Jahss the proximal fragment is held down and not allowed to go through its full physiologic excursion until it is anchored by the carpometacarpal joint capsule. Thus, the amount of upward force on the flexed proximal interphalangeal joint is materially reduced. Unlike the method of Jahss the pressure pads are adjustable, allowing the operator to regulate frequently the pressure and daily extend the proximal interphalangeal joint. This eliminates its greatest difficulty, namely, a pressure sore or flexion deformity at this joint.

The neck of the metacarpal which is the smallest and weakest portion of the bone is the most common site of the fracture. The fracture is more frequently transverse in character. The resulting deformity is that of a depression of the head with dorsal angulation of the fragments. The more dorsal the striking force against the head the greater is the depression of the knuckle. The more direct the force on the head in the longitudinal axis of the metacarpal

the greater the degree of impaction. A tangential force results in depression of the head with impaction and angulation of the fragments.

Normally the interosseous and lumbrical muscles insert into a loose aponeurotic sleeve over the dorsum of the proximal phalanx just distal to the metacarpophalangeal joint. (Fig. 1.) Contracture of these two muscles results in flexion at the metacarpophalangeal joint.

Following a fracture of the metacarpal with depression of the metacarpal head, the directional pull of these muscles is altered and the proximal phalanx is pulled into hyperextension. (Fig. 2.) The greater the flexion deformity of the metacarpal, the more will be the hyperextension pull of the lumbrical and interosseous muscles, the shorter will be the relative length of the flexor profundus and sublimis tendons and the greater will be the flexion deformity of the interphalangeal joints.

This deformity in the laborer interferes with his grasp of an implement. The inability to flex the affected finger completely results in weakness of the flexion power of the adjacent fingers. The prominent head of the metacarpal in the palm of the hand may cause pain when a object such as a tool is grasped. Depression of the knuckle, prominence on the dorsum of the hand, hyperextension at the metacarpophalangeal joint and flexion deformity at the interphalangeal joints are cosmetically objectionable to women.

Unfortunately in this fracture which is so easily reduced it is difficult ordinarily to

maintain the corrected position. Since this type of fracture is usually first seen by the general practitioner, it is invariably treated by him with one of the many more simple methods available. These usually include the ball or roll of bandage splinted in the

cated by Jahss, for a period sufficient to see callous on the x-ray film often results in a flexion deformity.

With the fracture once reduced, the operator will find that very little upward pressure on the head of the metacarpal

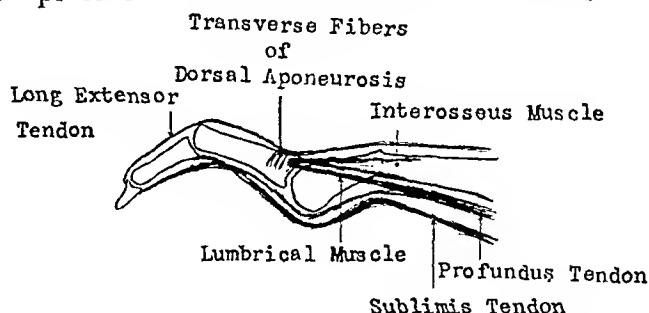
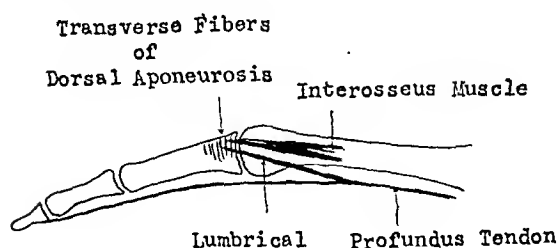


FIG. 1. A schematic drawing demonstrating the normal relationship of the interosseous, lumbrical and profundus muscles.

FIG. 2. A schematic drawing demonstrating the relationship of the intrinsic muscles after a flexion deformity of the metacarpal has occurred. The force of the lumbrical and interosseous muscles have been altered from a ventral to a dorsal pull. Because of the hyperextension deformity at the metacarpophalangeal joint, the sublimis and profundus tendons have become relatively shortened, thus causing a flexion deformity at the distal interphalangeal joints.

palm of the hand or various types of plaster of paris, wooden or leather splints. Surgeons have used more complicated methods: Bosworth<sup>3</sup> maintains position by fixing the fragments with rigid wires into the adjacent metacarpal, Meltzer<sup>4</sup> employs the skeletal wire traction through the proximal phalanx, Carr<sup>5</sup> maintains the position of the fragments by inserting specially constructed ice tongs into the proximal phalanx and Bunnell<sup>6</sup> uses longitudinal and transverse Kirschner wires.

The ball or roll of gauze in the palm of the hand does not counteract but rather emphasizes the angulating pull of the lumbrical and interosseous muscles thereby increasing the deformity. Skeletal traction of any form or skeletal fixation introduces the danger of infection. When plaster is used, it is too difficult to determine the exact amount of pressure necessary to maintain the position of the fragments. Too much pressure will result in pressure sores during the swelling stage which ensues within a few hours following reduction. Too little pressure will result in reangulation when the swelling subsides. Constant immobilization of the flexed proximal interphalangeal joint, as advo-

and downward pressure over the distal end of the proximal fragment is necessary to maintain the corrected position. However, an upward force cannot be made at this time on the plantar surface of the metacarpal head since pressure of any consequence on the intervening flexor tendon sheath would irritate its membrane and result in thickening and adhesions. In order to eliminate pressure over the flexor tendon sheath the metacarpophalangeal and first interphalangeal joints are flexed to form right angles. This places the base of the proximal phalanx beneath the head of the metacarpal. Slight pressure exerted upward against the head of the flexed phalanx results in elevation of the metacarpal head and easily maintains the corrected position of the fragments. The amount of pressure necessary is merely the equivalent of overcoming the angulation deformity caused by the pull of the interosseous and lumbrical muscles.

The instrument originally described has been in use by the author and also by his associates since 1941 with equally good results. These fractures were originally treated with a metal splint using the flexed finger throughout the entire period of im-



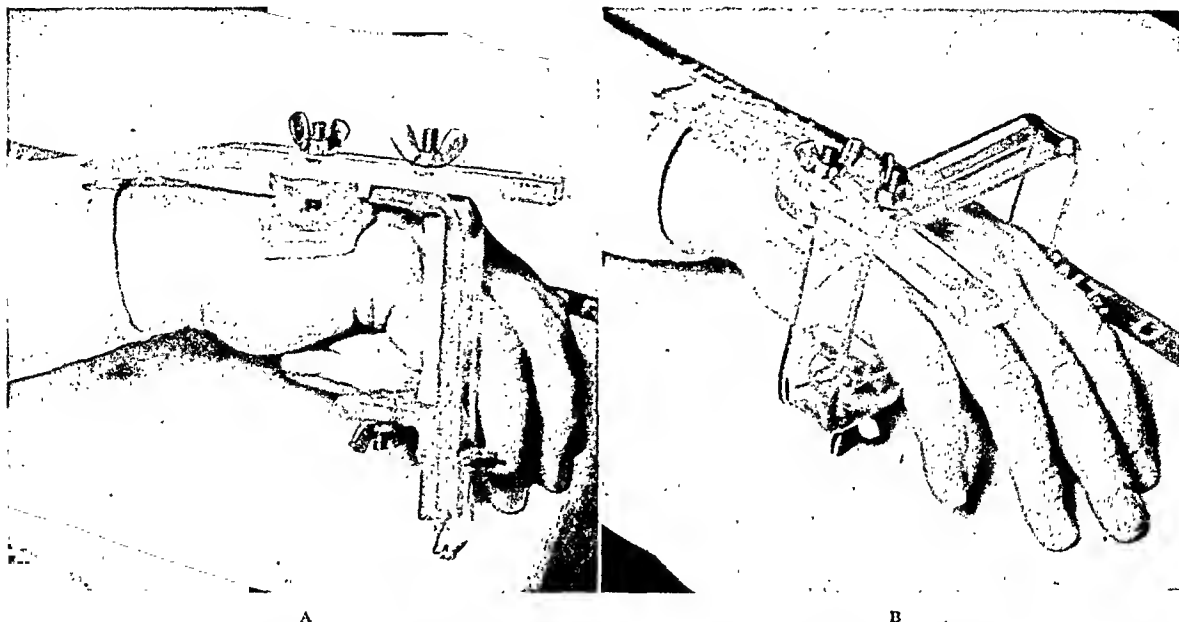


FIG. 3. A and B, the original and the modified splints incorporated. Both splints can now be used throughout the entire course of treatment. A is used during the first three or four days of treatment. The distal attachment is then removed by a simple bolt and the square attachment applied. This allows the involved finger to be extended during the remaining period of immobilization.

mobilization. (Fig. 3A.) At that time it was necessary to see the patient every second or third day in order to extend the proximal interphalangeal joint and thus avoid a flexion contracture. An attempt was then made to eliminate the necessity of seeing the patient so frequently.

After the first three to five days the swelling of the soft tissues and the spasm of the traumatized interosseous and lumbrical muscles had subsided. Therefore, it was believed that a slight amount of upward pressure on the ventral surface of the metacarpal head at this time would not irritate the flexor tendon sheath. A square attachment (Fig. 3B) was then devised which applied the upward pressure directly beneath the metacarpal head. This proved to be satisfactory but one difficulty was encountered. The splint which was constructed of metal obstructed adequate visualization of the fragments on the roentgenogram. Hence, on a subsequent case the splint was constructed of a plastic material and proved more satisfactory since it was radiolucent.

An attempt was then made to combine both instruments into one in order to

simplify replacement of the vertical arm with the square attachment. This was accomplished by using a simple bolt to disconnect the vertical arm and replace it with the square attachment. Roentgenograms of a typical case are demonstrated. (Fig. 4A to D.)

#### TREATMENT OF A SIMPLE IMPACTED FRACTURE

The hematoma at the fracture site is injected with about 5 cc. of a 1 per cent solution of procaine hydrochloride. (Fig. 5.) Any skin glue such as compound tincture of benzoin, gum mastic or Ace adherent is applied to the distal half of the forearm and the glued area is now covered with a 2 or 3 inch circular stockinette. After ten or fifteen minutes the fracture site will have become anesthetized and the fragments are forcibly broken up to disengage the impaction. *This is absolutely imperative.*

The fragments are easily aligned by applying upward pressure on the palmar surface of the metacarpal head and downward pressure over the distal portion of the proximal fragment. The patient now maintains the corrected position by placing the

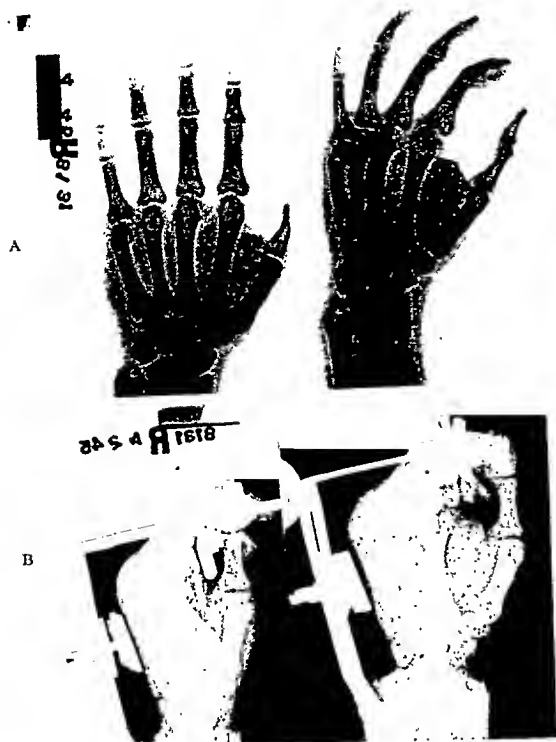


FIG. 4. A, simple fracture through the neck of the fifth metacarpal; B, fracture reduced and the original splint applied.

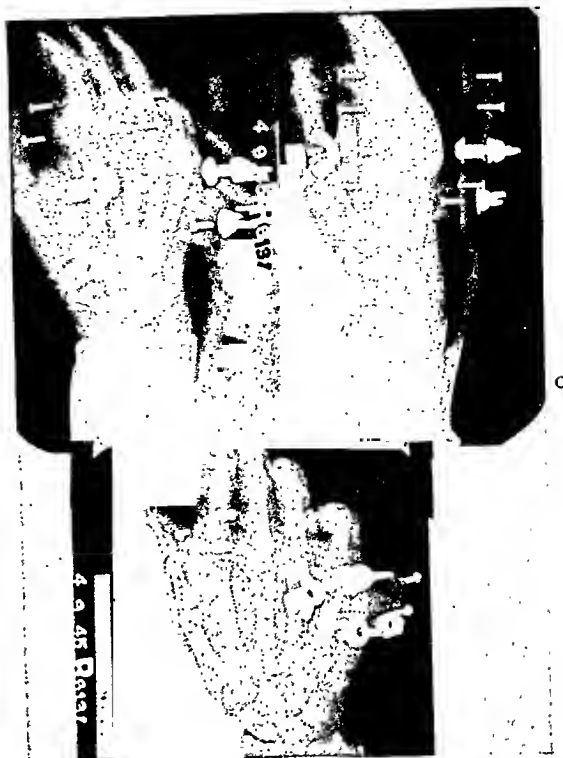


FIG. 4. C, the modified splint applied four days later shows the position of the fragments maintained.

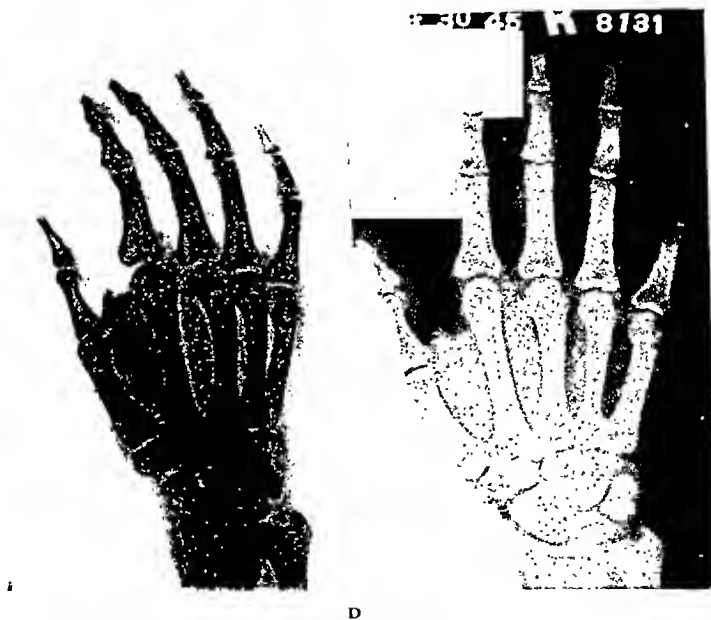


FIG. 4. D, twenty-six days postreduction; fragments in good position; motion of fifth finger normal.

index finger of his other hand beneath the metacarpal head and his thumb over the dorsum of the hand just proximal to the fracture site. The operator then applies a few turns of plaster of paris bandage about

the forearm over the stockinette. The long arm of the splint (Fig. 3) is then applied in the line of the involved metacarpal and anchored to the forearm with another few turns of plaster. In a few moments the

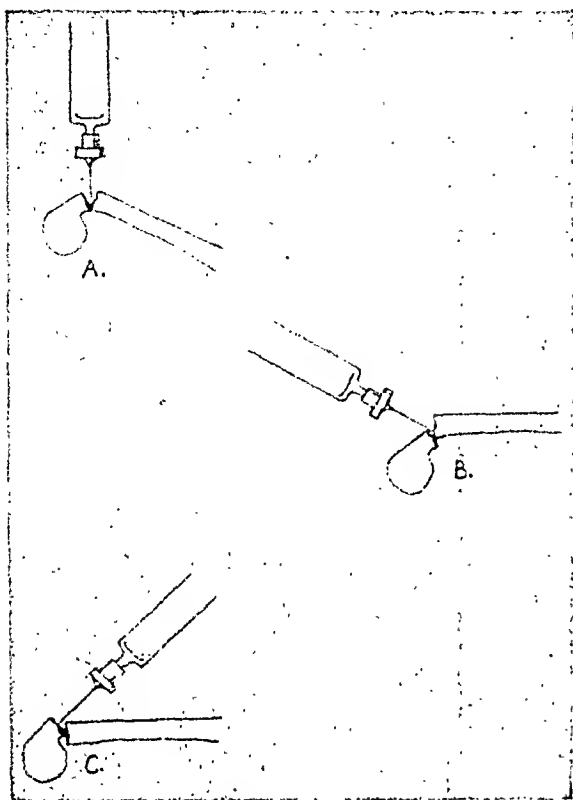


FIG. 5. A schematic drawing demonstrating the various directions of the hypodermic needle to facilitate striking the hematoma at the fracture site. At this point about 5 to 10 cc. of a 1 per cent solution of novocain is injected in order to produce analgesia.

plaster will have set. The upper set screw is then adjusted so that the pressure plate rests directly over the metacarpal and is proximal to the fracture line. The involved finger is then flexed to right angles at the metacarpophalangeal and proximal interphalangeal joints. The patient now exerts upward pressure on the distal fragment by pressing upward on the flexed proximal interphalangeal joint and downward on the dorsal pressure pad. The vertical arm is now attached to the long horizontal arm by means of a bolt and nut. (Figs. 3A and 6.) The lower support bracket is raised so that it approximates the dorsal surface of the flexed second and third phalanges. The knuckle is thus maintained in its normal prominent position.

If the fifth metacarpal is involved, it will be noticed that the two terminal phalanges will deviate radially. Hence, a

third set screw is placed at the lower support in order to adjust it to the proper angle. The upper plate is supported by a universal joint in order to allow for slight variations in the size and shape of the hand and still maintain an even distribution of force throughout the entire contact surface which is covered with a felt pad. To prevent the possibility of rotation of the fragments it is advisable that the next normal finger be flexed with the involved finger and then released either immediately or after one or two days. The lower pad can be placed transversely to accommodate both flexed fingers. It can also be angulated to compensate for the different lengths of the proximal phalanges.

*First Postoperative Day.* Twenty-four hours after reduction the operator's thumb can be placed beneath the involved metacarpal head and his index finger over the upper pressure pad. With the position maintained in the aforementioned manner, the lower pad is released and the flexed finger carried through a full range of motion at the proximal interphalangeal joint. The finger is lightly massaged with any oil, flexed again and the lower pressure pad reapplied. This procedure is carried out daily for three to five days to eliminate the possibility of a pressure sore and flexion deformity at the proximal interphalangeal joint.

*Square Attachment.* After three to five days the swelling of the hand and the spasm of the lumbrical and interosseous muscles, which is the deformity element, will have subsided. The fragments are again temporarily held by the patient or the operator. The vertical attachment is removed and the square attachment is applied. (Fig. 3A and B.) Pressure pads are then adjusted (Figs. 3 and 7) and in this manner the patient had practically a full range of finger motion. It is now necessary to see the patient only once or twice weekly until callous is visible at the fracture site which usually takes three to five weeks. The splint is then removed and no further treatment is necessary.

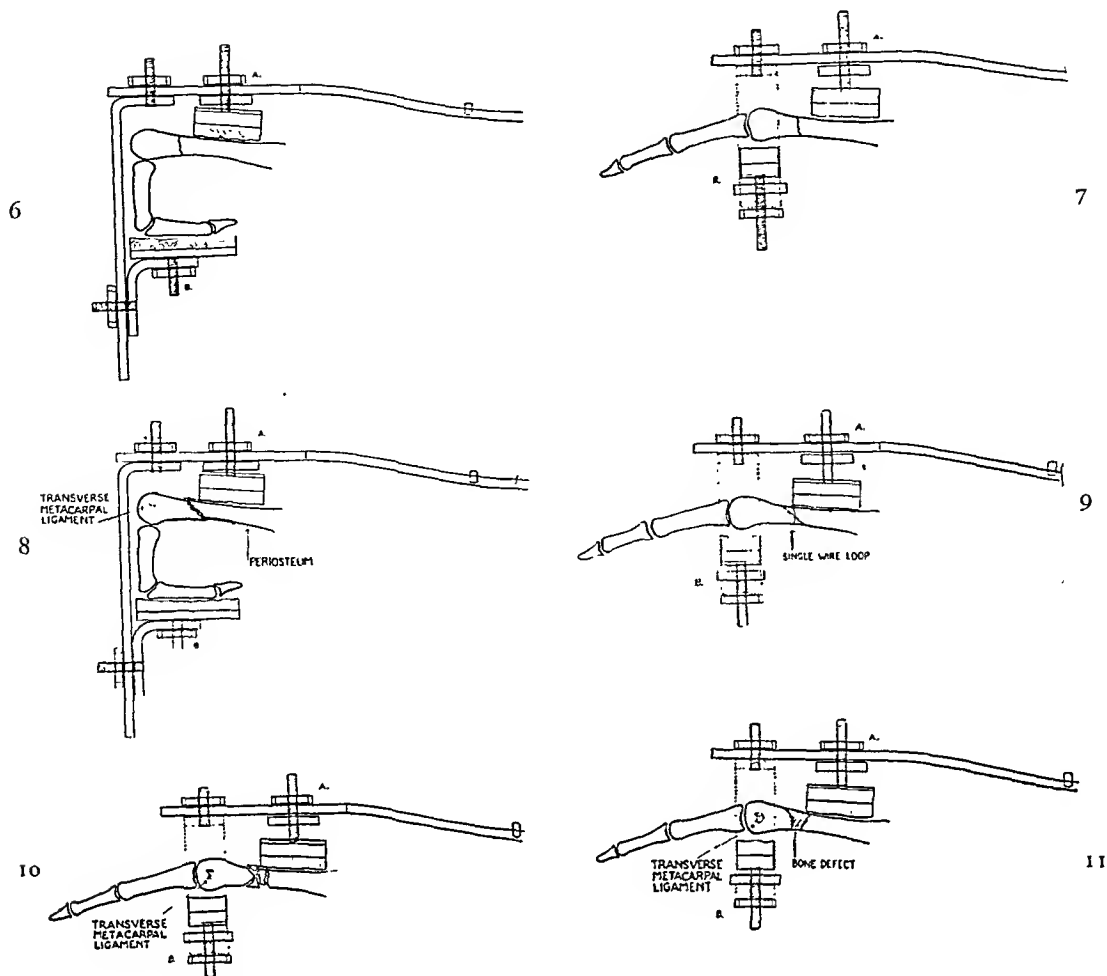


FIG. 6. The vertical attachment applied to a simple fracture through the neck of a metacarpal. Pressure at "A" and "B" applied through the intervening extensor tendon during the variable phases of swelling and muscle spasm following reduction.

FIG. 7. The square attachment applied to a simple fracture through the neck of a metacarpal. This attachment is applied three to five days after closed reduction. Pressure now at pad "B" is insufficient to cause injury to the intervening flexor tendon sheath.

FIG. 8. The vertical attachment applied to a simple oblique or spiral fracture through the shaft of a metacarpal. When reduced, the "saw-tooth" edges of the fragments, the "sleeve-like" effect of the periosteum and the "anchorage" of the transverse metacarpal ligament to the adjacent metacarpal may be sufficient to prevent over-riding while the splint maintains position.

FIG. 9. The square attachment applied to a simple oblique or spiral fracture through the shaft of a metacarpal. If the fragments slip after closed reduction, a single wire loop can be inserted into a small drill hole under local anesthesia. The wire loop tends to overcome some of the angulating pull of the lumbricals and interosseous muscles.

FIG. 10. The square attachment applied to a comminuted fracture through the shaft of a metacarpal. The anchorage of the transverse metacarpal ligament to the adjacent metacarpal prevents marked shortening. Good alignment in spite of little shortening leaves a satisfactory functional result. Pressure at "B" is lessened since the slight bone shortening diminished the angulating force of the lumbrical and interosseous muscles.

FIG. 11. The square attachment applied to a compounded war injury with a bony defect. The splint holds the fragments in good alignment until the soft tissue wounds heal. The pressure pad at "A" may easily be released when change of dressing is necessary. Apparatus may be reapplied after bone graft is inserted.

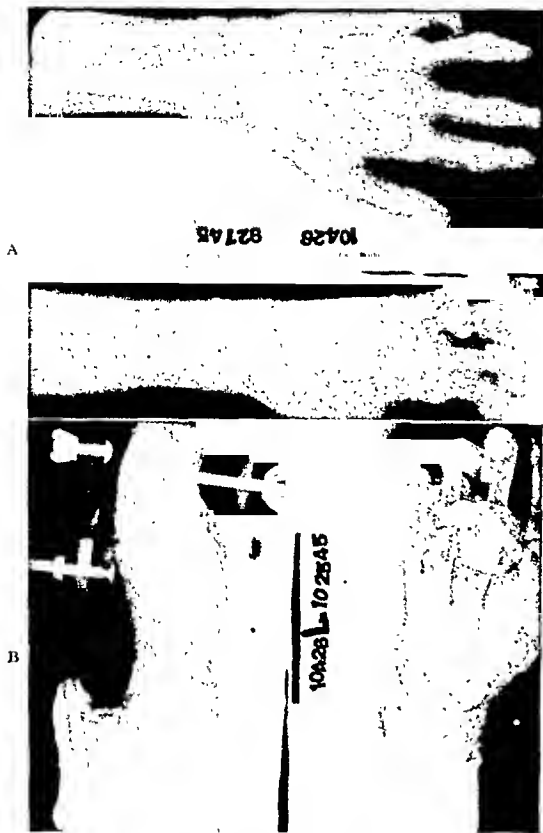


FIG. 12. A, malunited fracture near base of third metacarpal with palmar angulation of distal fragment; bullet wound first seen three months after injury. B, the deformed fifth finger was disarticulated at the proximal interphalangeal joint; the middle phalanx was used as a bone graft; open operation performed on third metacarpal which was united by fibrous union; graft held *in situ* with silver wires; fragments maintained in good position three weeks post-operatively.

#### HANDLING OF OTHER FRACTURES

*Transverse or Oblique Fractures.* Occasionally the periosteum, the anchorage of the transverse metacarpal ligament to the adjacent metacarpal and the "saw-tooth" shape of the fractured fragments will hold them from over-riding. In that case the fragments can be immobilized in the usual manner. (Fig. 8.) On the other hand, if the fragments slip, it is a simple procedure to approach the fragments through a small dorsal incision under local anesthesia and insert a single wire loop through a very small drill hole in each fragment. The wire loop counteracts some

of the angulating pull of the spastic lumbrical and interosseous muscles hence obviates the necessity of using the vertical attachment. Therefore, the square attachment may be applied immediately after reduction. The upper pad is placed directly over a small dressing which can be held in place with any skin glue. (Fig. 9.)

*Compound Fractures.* The wounds can be cleaned and dressed in the usual manner. Slight shortening of the metacarpal diminished the angulating pull of the spastic lumbrical and interosseous muscles. The square attachment may be directly applied. (Fig. 10.)

*Fractures Caused by War Injuries.* When bony defects are encountered as a result of bullet or shell fragment injuries, the wounds can be débrided and dressed in the usual manner. The square attachment is applied over the dressing. If the wound is left open, the fragments can be held by the operator while the pressure pads are removed and the wound can be redressed. The pressure pads are then re-applied. In this manner the fragments are held in good alignment until the soft tissues have healed. (Fig. 11.) By this time the intervening fibrous tissue will hold the fragments and prevent angulation. At some subsequent date an open operation can be performed, a small bone graft inserted, held *in situ* with a single wire loop at each end and the square attachment reapplied. During this entire procedure the patient has full motion of all his fingers.

*Malunited Fractures.* Open operation followed by osteotomy of the fragments is simply performed. The square attachment is then directly applied. If there is fear that the fragments might slip, then a single wire loop can be inserted into both fragments.

*Ununited Fractures.* The intervening fibrous tissue is excised. The fragments are freshened and a small bone graft may be applied. The graft can be held *in situ* with one or two small wire loops. (Fig. 12A and B.)

## CONCLUSION

A simple mechanical device has been described for use in the treatment of all types of fractures involving the four lateral metacarpal bones.

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ACCORDING to T. Horwitz, in congenital or developmental coxa vara, drilling of the femoral neck or implantation of a bone graft through it as a supplemental procedure to corrective osteotomy is unjustified. He tried these methods in a small series of cases but found them of no particular value. Any child with a painless limp may have this deformity. Pain later appears in adolescence or adult life as a result of increasing deformity, especially of the femoral neck, and shortening of the involved extremity. X-rays are diagnostic, of course. Simple subtrochanteric osteotomy (or intertrochanteric osteotomy) is followed by satisfactory results in most cases. Recurrence may occur especially in those with chronic cases who are operated upon too late, and undoubtedly secondary degenerative changes in the femoral head and neck will be found by x-rays in many of these instances. (Richard A. Leonardo, M.D.)

# A THREE-WAY INFUSION VALVE FOR BIOLOGIC FLUIDS

WILLIAM BIERMAN, M.D.

*New York, New York*

THE valves employed in medical practice today appear to be direct adaptations of those used commercially for gases and liquids. The problems encountered when it is desired to transfer biologic material from one channel to another

are of standard size. A short metal arm attached to the rotating portion of the valve points in the direction of the channel through which the fluid is flowing. Guiding pins placed on the side of the valve to limit the excursion of this metal arm cause

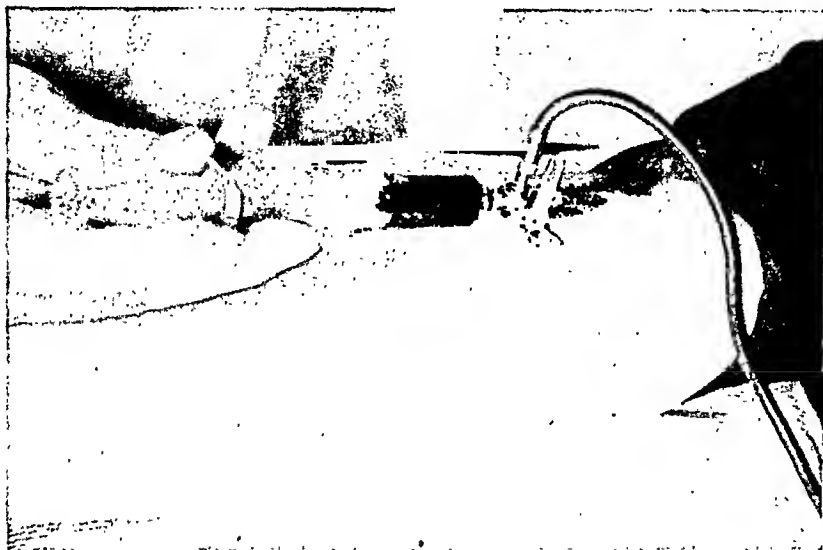


FIG. 1. Illustration of three-way infusion valve.

would indicate the necessity for a device which would be better suited for its purpose than the present commercially inspired valves.

The author has accordingly devised a three-way metal valve designed to facilitate work with blood and with other biologic fluids. This valve has the great advantage that it can be readily taken apart for cleaning and can be reassembled with equal ease and speed. This, in addition to large channels, makes it a simple matter to remove material such as blood clots, fibrinous or other masses which might clog the instrument.

The valve, shown in the illustration, consists essentially of two sections, one a tapered member fitting easily into the opening of the other. These are held together snugly by an outside spring. The spring tension although firm is adjusted to allow the valve to be turned easily. The connections for syringe and adapters

exact alignment of the desired channel. This permits the operator to turn the valve by the sense of touch and without necessarily looking at it.

The tapered portion of the valve on to which the needle fits is placed eccentrically so as to allow the needle to be held close to the skin surface. The crosspiece attached to the under surface of the valve permits it to remain in place when employed for intravenous work in an extremity. If desired the valve with its connections can be stabilized further by stretching strips of adhesive from the crosspiece to the adjacent skin.

*Acknowledgments:* The author wishes to express his thanks to Dr. A. W. Shenker of New York and to Mr. Emil Davidson of the Clay Adams Co. for their assistance in the construction of models of this valve, and to Dr. Ivan Brown of Duke University Hospital for helpful suggestions and for the testing of this apparatus.

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# The American Journal of Surgery

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A PRACTICAL JOURNAL BUILT ON MERIT

*Fifty-seventh Year of Publication*

VOL. LXXVI

SEPTEMBER, 1948

NUMBER THREE

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## Editorial

### FUNDAMENTALS OF PERINEORRHAPHY FOR COMPLETE LACERATIONS

A COMPLETE laceration of the perineum is one that involves the perineal body, the sphincter ani muscle and frequently the anterior rectal wall. This distressing lesion is generally the result of childbirth and occurs in the course of difficult deliveries although it may accompany an entirely normal labor. The prophylaxis of such a lesion is most important. There are three methods in common use of avoiding a complete tear of the perineum: first, perineotomy, or median perineal incision, when a moderate amount of room is required; second, medio-lateral episiotomy, performed on the side of the presenting part, right or left, or on both sides, as with bilateral episiotomy, when a great deal of room is required and third, manual dilatation of the perineum and vagina. The first two methods are preferable to the third because in the performance of manual dilatation of the perineum and vagina there is a varying degree of separation of the muscular and fascial structures under the intact mucous membrane and skin and, although at the completion of delivery the pelvic floor appears uninjured, a rectocele may develop.

There are two general methods employed in the repair of a complete tear of the perineum: the apron or flap method and the layer-suture method, with or

without rectal sutures. The former method was proposed in 1878 by J. Collins Warren of Boston who presented it to the American Gynecological Society in 1882. It consists of turning down a flap which is dissected from the posterior wall of the vagina and which covers the exposed mucosa of the rectum thus permitting placing of the sutures so that they will not be in contact with the interior of the rectal tube. In the layer-suture method the initial incision takes the form of the letter H. The various structures are mobilized and the rectum is sutured with fine silk, nylon or catgut, the knots being tied within the bowel lumen; the perirectal fascia is approximated over the rectal suture line, the ends of the sphincter ani muscle are approximated to each other in the median line, the levator ani muscles, the urogenital diaphragm and Colles' fascia are united and finally the skin is closed. The skin closure is accomplished with fine catgut or fine non-absorbable material, depending on the amount of tension on the edges due to the presence or absence of scar tissue. Both methods have given excellent results and the choice between them is a matter of personal preference. From the start I have used the layer method with rectal sutures, employing interrupted sutures throughout and since the results



have been satisfactory I have continued to operate in this manner. In 1944 the end results of 110 operations showed satisfactory results in 98 per cent of the patients, 15 per cent of whom had developed post-operative complications.

During the last decade these operations have been performed with fine suture material in contradistinction to the coarse material that was formerly used. Again, careful mobilization of the tissues and approximation without tension and strangulation have resulted in better healing and in the avoidance of fistula formation. This procedure was mainly the application of improved surgical principles to that particular lesion.

The time at which this operation is performed is important. As a general principle repair of a complete laceration of the perineum may be carried out immediately after the third stage of labor

if the patient is in proper condition and the surroundings are adequate for such repair. As a rule these primary repairs heal satisfactorily. If it is considered inadvisable to proceed with the operation immediately after delivery, at least three months and preferably six months should elapse before it is attempted. In the future the use of sulfasuxidine and of sulfathalidine may help to reduce the bacterial flora in the bowel and thereby be of value in promoting satisfactory healing.

Careful preoperative preparation, meticulous technic, gentle handling of the tissues, sharp rather than blunt dissection when possible and postoperative care under the immediate supervision of the operator all play an important rôle in securing satisfactory results.

LOUIS E. PHANEUF, M.D.



# Original Articles

## LUMBAR HERNIATIONS OF THE NUCLEUS PULPOSUS\*

### AN ANALYSIS OF 196 OPERATED CASES

E. S. GURDJIAN, M.D. AND JOHN E. WEBSTER, M.D.

*Detroit, Michigan*

THE common complaint of pain in the lower spine is occasionally related to symptoms and signs of nerve root compression. It has been recognized for many years that low back pain associated with lumbar or sacral root disturbance may be a transient condition suitably treated by conservative measures. It has also been known that such symptoms may warn of profound central nervous system disease, such as tumors involving the cauda equina; neoplasms of metastatic or local origin involving bone and contiguous neural structures; inflammatory conditions producing root traction and constriction; congenital malformations as in spina bifida occulta associated with intervertebral foraminal defects and root distortion or compression, and post-traumatic states with bony distortions and proliferation of scar and callous in and about the caudal canal.

Recently, attention has been focused upon a condition of nerve root compression caused by the protrusion or rupture of the nucleus pulposus of the cartilaginous disc. This is far more common than any of the other serious diseases involving nerve roots. Since 1934, when attention was called to the mechanism and treatment of this condition by Mixter and Barr,<sup>1</sup> a fuller understanding has gradually been achieved. Knowledge of the anatomy, physiology and pathology of the nucleus pulposus has been well established. Contributions by Bradford and Spurling,<sup>2</sup>

Dandy,<sup>3</sup> Deery,<sup>4</sup> Grant,<sup>5</sup> Love,<sup>6</sup> Naffziger, Inman and Saunders<sup>7</sup> and many others have served to fix the criteria for diagnosis and settle, in general, the plan of treatment. As in all new surgical procedures there still remains some controversial questions mainly concerning the time and type of surgical treatment.

In this report attention will be given mainly to a study of 196 patients having low back pain with sciatic radiation who were operated upon in a six-year period from September, 1940 to September, 1946. Certain lessons learned from this experience will be considered. An analysis will be made of the results and a brief review will be given of certain points in the syndrome of the herniated disc.

#### MATERIAL

It may be seen that male patients represented 65 per cent of the series. Table 1.

TABLE I  
AGE AND SEX INCIDENCE

Sex	Per Cent	Age	Per Cent
Males	65	20-30 yr.	10
Females	35	31-40 yr.	42
		41-50 yr.	36
		51-60 yr.	10
		61-70 yr.	1

The greatest number of herniated discs occurred in the age group of thirty-one to fifty.

\* From the Department of Surgery, Wayne University College of Medicine, and Department of Neurosurgery, Grace Hospital, Detroit, Mich.



FIG. 1. Ruptured disc of third interspace causing complete block; bilateral weakness of the lower limbs with ataxia and sensory level; paralysis of sphincters.

FIG. 2. The specimen was removed in one piece and was in a rolled position anterior to the longitudinal ligament; transdural removal.

The neurologic findings may be divided into two classes: First, those patients with little or no neurologic deficit and second, patients with severe neurologic deficit. Eight among the 196 patients had severe neurologic deficit. In two patients of this group, bilateral partial paralysis of both lower limbs, with sphincter disturbance and a sensory level of hypesthesia was present. (Figs. 1 to 4). In two cases there was saddle anesthesia, sphincter paralysis and unilateral foot drop. In four others

there occurred a unilateral foot drop with minimal sensory loss in the fifth lumbar dermatome on the affected side. (Fig. 5.) In this connection it should be mentioned that in two patients not included in this series the acute onset of foot drop with sciatic pain was associated with a spinal fluid total protein of 65 and 82 mg. per cent. No rupture or protrusion was noted at the fourth and fifth interspaces on the affected side. The possibility of an atypical toxic neuronitis imitating the disc syn-

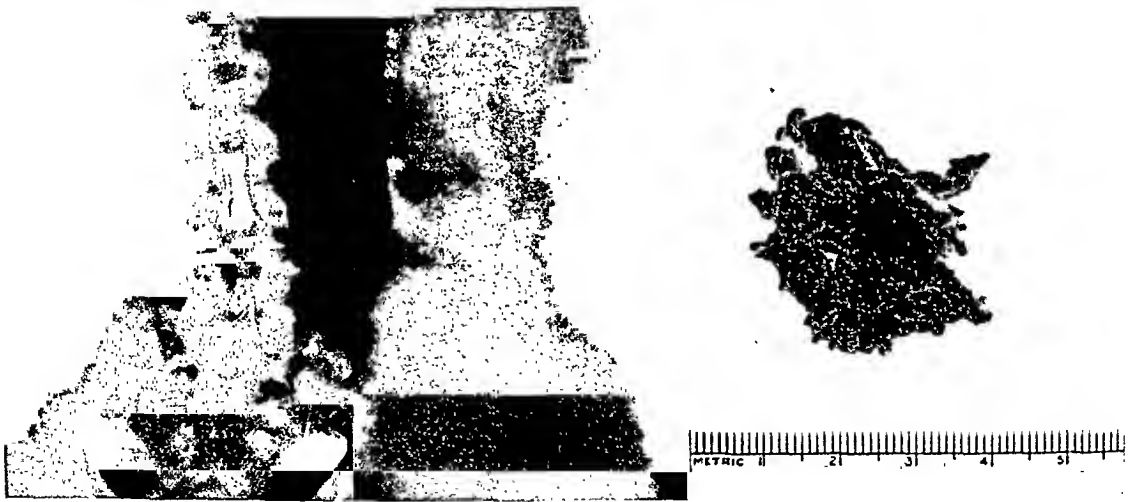


FIG. 3. Pantopaque myelogram showing complete block at the fourth interspace; bilateral foot-drop, sensory level, and sphincter paralysis were noted.

FIG. 4. Specimen was removed in one piece; transdural removal; similar to conditions described in Figure 2; this material was found "rolled up" anterior to the longitudinal ligament.

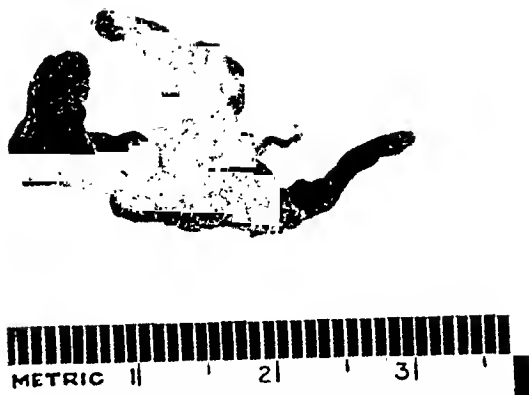


FIG. 5. Ruptured disc of fourth interspace on the left associated with a foot-drop and sensory loss of the fifth lumbar dermatome. The specimen extruded in one piece.

drome presents itself. Three patients manifesting symptoms suggesting ruptured nucleus pulposus were found to have sacral chordomas and four others, cauda equina tumors. (Figs. 6 to 8.)

TABLE II  
OPERATIVE FINDINGS

Ruptured or protruded discs.....	146
No disc herniation found at operation.....	28
Two disc herniations found (L4-5; L5-S1).....	9
Massive rupture of disc.....	8
Calcified disc.....	5

It is interesting to note that the development of severe neurologic dysfunction was very rapid in five of the eight patients with massive rupture (two to ten days).

TABLE III  
LEVEL AND SIDE INVOLVED

Levels	Per Cent	Side	Per Cent
L3-4	1	Left	54
L4-5	38	Right	45
L5-S1	61		

In 146 patients, operation involved single herniation. (Fig. 9.) Nine patients had two abnormal discs (Fig. 10), a single calcified protrusion was found in five patients and massive rupture occurred in eight patients. In twenty-eight patients no disc protrusion was found. (Table II). The left side was involved in 54 per cent of the

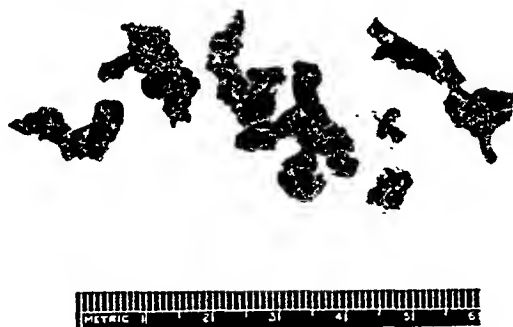


FIG. 6. Protruded discs at the fourth and fifth interspaces on the left. Following the removal there was some improvement of the leg component of the pain. The patient continued to complain of intractable low back pain.

patients and the right side in 45 per cent. Thirty-eight per cent of the abnormalities occurred between L4 and L5, 61 per cent between L5 and S1 and only two patients, or 1 per cent, had lesions at L3 to L4. (Table III.)

TABLE IV  
ABNORMALITIES IN TWENTY-EIGHT PATIENTS WITH NO DISC PROTRUSION

Varicosities of outgoing root.....	12
Root compression by contiguous tissue.....	7
Herniation of cauda equina filament through dural opening.....	1
Normal.....	8

Among the twenty-eight patients with the protruded or ruptured disc syndrome in whom no defect of the disc was found (Table IV), varicosities of the outgoing root were noted in twelve patients. In seven patients it was thought that there was root compression by contiguous tissue and in eight others the relationships appeared normal. Among those with vari-

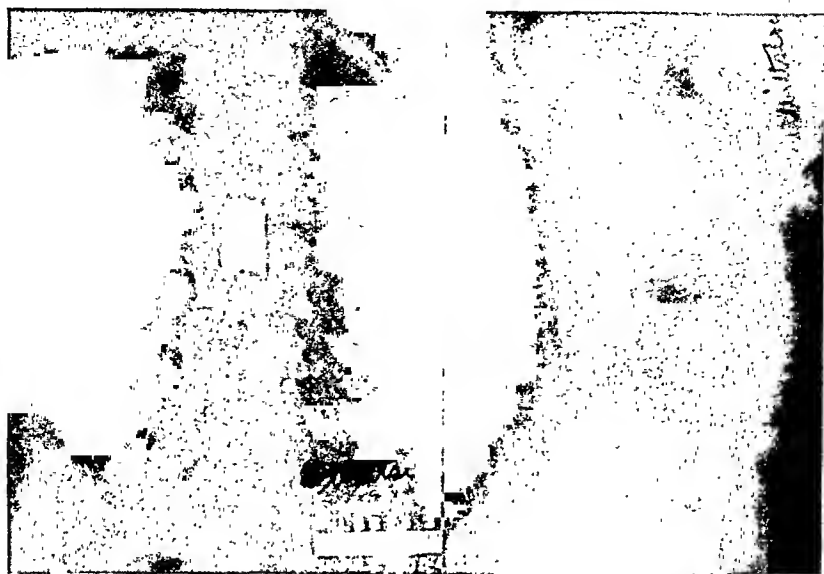


FIG. 7. Pantopaque myelogram in the case described in Figure 6 showing complete block at third lumbar level; spinal fluid total protein 75 mg. per cent.

cosities the gross pathologic picture was quite typical in every instance with epidural hemangiomatous tissue involving the outgoing nerve root, either at the lateral or medial aspect of the outgoing nerve trunk or surrounding it.



FIG. 8. Meningioma removed in previous case, with complete cessation of symptoms.

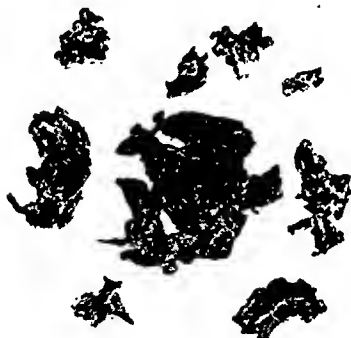


FIG. 9. Herniated disc removed "piece-meal."

All patients had spinal fluid examinations. In the greatest majority the total protein was slightly elevated, the average being 50 mg. per cent. In only four patients was the total protein above 100 mg. per cent. (Table v.) Pantopaque or lipiodol myelography was carried out in thirty-one patients. In twenty-one the myelographic and operative findings corresponded. In the remaining ten there were false-positive or negative findings. Subarachnoid air myelography was not diagnostic in our hands.

TABLE V  
SPINAL FLUID TOTAL PROTEIN

Average.....	50 mg. %
Above.....	100 mg. %, 2 %
Below.....	30 mg. %, 10 %

Every patient had roentgen studies of the spine made and in twenty-seven of the group significant coexisting spinal abnormalities were noted. In twenty patients there was a narrow disc but only in seven did this correspond to the affected interspace while in thirteen the narrowing occurred at other than the affected interspace. (Table vi.)

The type of operation performed in this series is tabulated in Table vii. Bilateral laminectomy was performed in twenty-three patients. In 121 patients the opera-

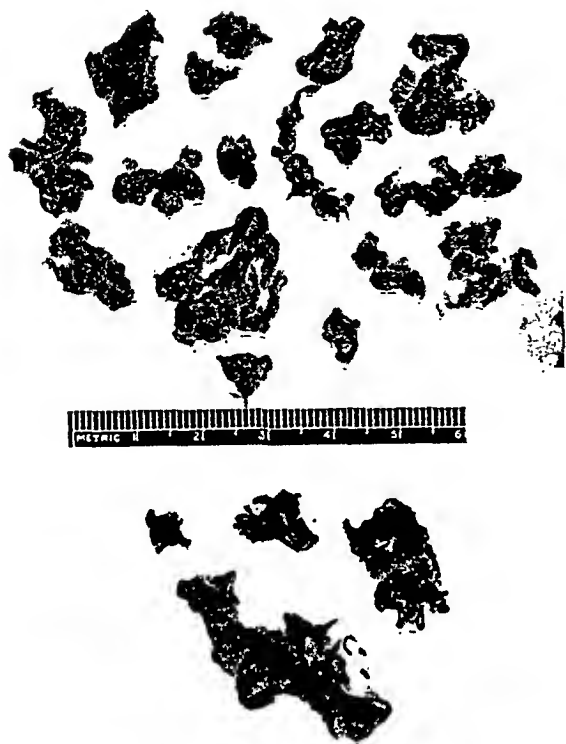


FIG. 10. Multiple ruptured discs; above pieces removed from the fourth interspace; below from the fifth interspace; routine exposure of both fourth and fifth interspaces is very worth while.

tion consisted of hemilaminectomy and exposure of the fourth and fifth interspaces on the affected side. (Fig. 11.) The posterior and lateral borders of the fourth and fifth

TABLE VI	
SIGNIFICANT X-RAY FINDINGS	
1. Significant spinal abnormalities (Arthritis, spondylolisthesis, iliac ostitis, sacroiliac arthritis, deforming spondylitis).....	27 cases
2. Narrowed disc spaces.....	20 cases
Affected disc.....	7
Unaffected disc.....	13
3. Contrast media studies.....	31 cases (15%)
Accurate.....	21
False-positive.....	5
Normal	
(disc present).....	3
Wrong level.....	2
In three patients of group 1, no disc was present.	
Air myelography (subarachnoid), unsatisfactory	

lumbar laminae were ronguered away until the superior edge and the lateral attachment of the ligamentum flavum were visualized. A blunt hook was passed under

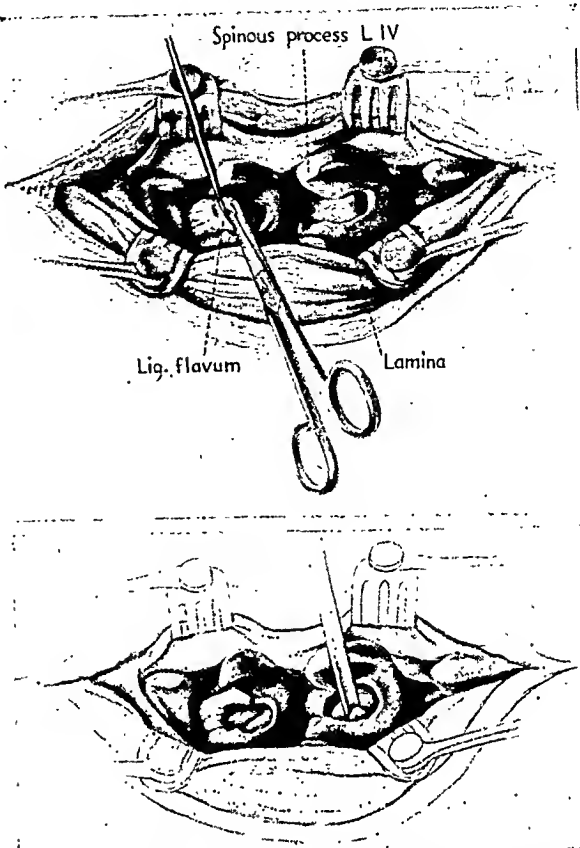


FIG. 11. Unilateral exposure of the fourth and fifth lumbar laminae. Excision of the posterior and lateral portions of the lamina until the anterior border and the lateral attachment of the ligamentum flavum are visualized; excision of the ligamentum flavum followed by inspection of the outgoing roots and the intervertebral discs.

the superior border of the ligamentum flavum which was excised. Care was taken to remove completely the portion attached to the spine laterally, otherwise a shelf of ligamentum flavum would obstruct the view in exposing small protrusions. Among those with bilateral laminectomy eight massive discs were removed transdurally and one extradurally. Combined hemilaminectomy at the fourth and fifth interspaces on the affected side with fusion of the lumbosacral spine was carried out in fifty-two patients. The fusion usually consisted of the use of a tibial graft, cancellous bone and osteoperiosteal graft. The non-laminectomized side was mainly used for the graft. In a few patients the procedure advocated by Moore<sup>8</sup> was used, the graft being applied with the patient in flexion



FIG. 12. Ruptured nucleus pulposus of fourth interspace on the left side causing a list to the right. Also note the difference in the size of the two legs; the left leg is atrophic.

to get the maximum separation of the vertebrae posteriorly. Most of our fused patients were ambulatory in two weeks.

In Tables VIII and IX, follow-up studies of eighty patients are reported. Ordinarily the results have been satisfactory. Compensation cases have not fared as well as private ones. The convalescence was short



FIG. 13. Lipiodol study of the lumbosacral dural sac. A ruptured nucleus was visualized at the level of the fifth interspace on the right side.

TABLE VII  
TYPE OF OPERATION

Laminectomy bilateral.....	23
(Transdural removal 8)	
Hemilaminectomy (partial).....	121
Combined operation with fusion.....	52 (26%)
No disc found in eight of the fusion patients	

TABLE VIII  
FOLLOW-UP STATISTICS IN EIGHTY PATIENTS

	Cases	Poor Results	Compensation
6 months-1 yr.....	31	4	3
1-2 yr.....	23	2	1
2-3 yr.....	14	2	
3-4 yr.....	8	0	
5 yr. plus.....	4	1	

TABLE IX  
RESULTS IN EIGHTY PERSONS  
Per Cent

Excellent.....	43 (Essentially cured)
Good.....	25 (Greatly improved; working)
Fair.....	20 (Improved; working)
Poor.....	12 (Unimproved; not working)
Of the twenty-five fused patients results were:	

	Per Cent
Excellent.....	36
Good.....	32
Fair.....	24
Poor.....	8

(two to six weeks) or long (two to four months). We divided our results into four groups: excellent, good, fair and poor. By excellent we mean complete recovery. Good results are obtained in patients who may have attacks of pain on exertion but which are not serious enough to incapacitate them. Fair results are characterized by patients who carry on with their work in a lighter job, with backaches or leg pain to contend with from time to time. Poor results are obtained in those who are made no better by the operative intervention. There has been an occasional instance of a patient with an excellent result having a non-incapacitating recurrence of symptoms after three or four years.

Nine in this group had secondary operations, three were patients from other clinics and six were our own cases. Among the latter, five were re-operated upon at our hospital and one was operated upon in another clinic. The results among the re-operated group have been satisfactory with the exception of one patient in whom a cordotomy was performed as a last resort. Among the re-operated patients, material was removed from the same interspace in two instances and from another interspace in the remaining three. In the patient re-operated upon at another clinic a nerve root was found to protrude through a small opening in the dural sac with a spurious meningocele. The original opening in the dura, which had been closed with silk, had been utilized to drain the contrast medium used for myelography.

#### COMMENTS

The pathologic conditions of the intervertebral disc include (1) a posterolateral bulging of the nucleus through a weakened portion of the annulus fibrosus, producing a protruded disc; (2) rupture of the nucleus through the annulus and the posterior longitudinal ligament, commonly designated as ruptured disc; (3) a degenerated nucleus and annulus causing reflex pain by internuncial communications in the spinal cord in the same dermatome as the out-

going nerve, producing a referred pain in the back and sciatic distribution and (4) Schmorl's nodes or rupture of the nucleus into the body of the vertebrae above or below, giving a characteristic roentgen appearance.

The symptoms in posterolateral herniation of the nucleus include pain in the lower back with radiation into one or both lower limbs along the posterior aspect of the hip, thigh, posterolateral aspect of the leg and the foot in some cases.

The pains are typically sharp and shooting in character, at least part of the time, and are made worse by coughing, sneezing or straining at stool. Occasionally coughing or sneezing has no influence upon the complaints. The backache may precede the sciatic radiations by months or years and then again the sciatic component may be present without the low back pain. During the acute attack the pain may be intractable, producing total disability, gradually subsiding under rest to become subacute, chronic or completely remissive. The less acute back pain may have a "catch-like" quality, is often worse at night and is eased by walking or sleeping in a chair. Paresthesiae and hyperesthesiae may be noted in the affected lower limb.

In patients with minor neurologic deficit there may be pain on straight leg raising; a list away from the side of the lesion (Fig. 12); pain in the lower back upon compression of the neck veins or upon forward flexion of the head and neck and pain upon bending backward or toward the lesion. Percussion of the involved interspace may produce typical radiations of pain.<sup>2</sup> The knee jerk may be lost with third interspace involvement. Weakness of the extensor hallucis longus occurs with involvement of the fourth interspace; the achilles jerk is frequently lost with a rupture at the fifth interspace. Sensory defects may be minimal, usually found along the lateral aspect of the leg with some involvement of the big toe, with fourth interspace lesions. With fifth interspace involvement the sensory deficit



involves the lateral three toes and the corresponding portion of the foot. It should be emphasized that in some cases the neurologic findings are entirely negative, except for pain on straight leg raising.

Severe neurologic deficit as foot drop, saddle anesthesia and sphincter disturbance are associated with massive rupture at the fourth and fifth interspace. Paralysis of both lower limbs with varying degrees of sensory loss and sphincter dysfunction are found with rupture at the level of the third or fourth interspaces.

Roentgen examination is an important adjunct in diagnosis. The presence of sacroiliac arthritis, spondylolisthesis, lumbar spinal arthritis, Marie-Strümpell disease, metastatic lesions of the lumbar spine, tuberculosis and sacral chordoma may thus be determined. It should be emphasized that a ruptured or protruded disc may coexist with spinal arthritis, sacroiliac arthritis, iliac osteitis and spondylolisthesis. The presence of a narrowed intervertebral disc does not necessarily indicate the level of a ruptured or protruded nucleus.

Our patients have been punctured for study of the spinal fluid. The total protein is frequently slightly elevated. Only occasionally is it over 100 mg. per cent. The use of myelography is worth while (Fig. 13) in the doubtful case to determine the presence of multiple lesions or rule out a neoplasm. In our hands there is an error of 25 to 30 per cent counting false-positives and false-negatives.

Indications for operation may be classed under two headings: First, in patients with severe neurologic deficit. In this group immediate operation is indicated. Second in those patients in whom the chief complaint is disabling pain. Operation is usually not the method of choice in patients having a first attack of backache and sciatica. If symptoms persist for many months in spite of leg traction, therapeutic injections along the lower spine, boards under the mattress, caudal injections, lumbosacral support or a body cast, operation may be advisable. In patients with

recurrent attacks of backache and sciatica and in those subjects with a history of backache for many years with recent sciatic radiation for the first time, operation is justified.

Twenty-six per cent of our patients have had spinal fusion. Fusion has been used in patients who in addition to the herniated nucleus syndrome also had evidences of an unstable back (lordoscoliosis of the lower lumbar spine, sacralized fifth lumbar vertebra, unstable fifth lumbar vertebra as evidenced by asymmetrical facets) and when the syndrome is associated with spondylolisthesis. Patients with long continued and intractable backache with sciatic radiation are explored for a protruded or ruptured disc followed by fusion. Fusion is performed after exploration in patients who toil at hard labor, with bending and lifting essential in their occupation.

*Operative Technic.* Partial hemilaminectomy, excision of the ligamentum flavum and the ruptured disc, with eurenting of the interspace, is quite adequate. The fourth and fifth interspaces are routinely explored. In patients with severe neurologic deficit when a massive protrusion is found extending into the spinal canal, bilateral laminectomy and either transdural or extradural removal of the disc is the procedure of choice. This is preferable to bilateral hemilaminectomy since the block may be due to an intradural or cauda equina tumor. In the absence of a ruptured disc it is then a simple matter to explore the dural sac. In patients who are fused, hemilaminectomy at the fourth and fifth interspaces of the affected side has been followed by tibial massive graft, osteoperiosteal and cancellous bone graft. This combined operation has always been performed with an orthopedic colleague.

The pathologic picture disclosed at operation has been varied. A ruptured or protruded disc, varicosities about the nerve root and, in some instances, compression of the outgoing nerve root by surrounding tissues has been verified in the greatest majority of cases.

The postoperative behavior of patients with herniation of lumbar discs varies. The convalescence in some cases is protracted with eventual recovery. Many are only freed from incapacitating symptoms. Others make a complete recovery.

#### CONCLUSIONS

1. A narrowed intervertebral disc by x-ray does not necessarily indicate a rupture of the disc.
2. Myelography is misleading in 25 to 30 per cent of the cases, either by being falsely positive or negative.
3. Pain may be the only indication of a herniated disc in some cases. A typical combination of signs and symptoms is obtained in most cases of ruptured disc.
4. In most cases, operation may be deferred in the first attack of low back pain with sciatica.
5. Massive ruptured disc with severe neurologic deficit deserves immediate operative attention.
6. Fusion has been used in this series of cases with spondylolisthesis, unstable fifth lumbar vertebra, long history of backaches and in some patients who toil at hard labor.

7. Results on the whole have proven satisfactory. Cases combined with fusion and those with small hemilaminectomy have shown approximately the same results.

8. Exploration of the fourth and fifth interspaces routinely on the side of the pain as suggested by Dandy is a satisfactory procedure.

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## FADS AND FANCY IN TREATMENT OF PEPTIC ULCER\*

FELIX CUNHA, M.D.

*San Francisco, California*

SEVERAL years ago at a meeting of one of the gastro-enterologic societies an eminent gastro-enterologist from the South announced in a dramatic way that there and then he wished to announce a new cure for peptic ulcer. As a sort of build up he unfolded a story of how this new cure, and he was quite sure that it was going to be miraculous, had been given to him by an old lady of the Texas hinter land whom he had come across while on a hunting trip into the back country.

The cure consisted of lying down after each meal and rubbing some hot bear grease across, onto and into the epigastrium or wherever the pain might be located. The gentleman said that now that he had announced his miraculous cure he was going to sit back and watch developments. He fully expected an onrush of the press and he was quite sure that their interest in the welfare of the people would cause them to carry the message of this new cure into every home and hamlet in these United States. The next development which he foresaw was an onslaught on the part of the commercial purveyor of anything that would help anybody's ailment, particularly if there was any angle to it that would make a cash register ring lustily.

In the ordinary course of the evolution of his discovery he felt sure that some one would announce that his particular brand of bear grease was better because the bear had been shot at night or by moonlight when he was in a tranquil mood, and his endocrines had not had any chance to exercise any constricting or frustrating influence of fear and such. He felt quite sure that some concern would announce that they had hired a famous Canadian

bear trapper and that their bears were humanely trapped, then installed in cages and fed the proper vitamins and hormones. Then the bears would be taken completely unawares and shot through the brain with one bullet and one only, therefore their grease was best.

Quite naturally, the doctor was being facetious but perhaps there was a point to his remarks. The treatment of peptic ulcer has at times assumed the aspects of the acme of the ludicrous and such a fantasy as he pointed out has its analogy even down to our present super modern methods. Need I refer to those patients who suffered, God knows what, offense not only to their esthetic sensibilities but to their physical as well when they tried to down the super-prepared mucin in their laudable efforts to obtain relief of their symptoms. Surely the picture in recent medical journals of one of the men of achievement sitting nonchalantly in a well padded and most comfortable looking library chair reading a book, with a Levine catheter coming out of his mouth attached overhead to a glass jar containing a "new" antacid in such manner that a continuous 60-72 drop per minute is supplied within the stomach makes one stop and wonder. A cynic suspects immediately that the gentleman in the picture is far too contented looking to be an actual sufferer from ulcer. Just possibly he is there as a paid model getting a pretty good fee for the short time he has to endure the discomfort, at least his appearance suggests just that. One would think that alone would destroy the effectiveness of the advertisement. The poor fellow who really has an ulcer has to live with the thing, has to take it to the bathroom and life

\* Read before the Harlow Brooks Medical Conference on the Navajo Reservation, Ganado, Arizona, August, 1947.

for him does not consist of sitting in a chair reading a book. For him as for all of us there are human processes to be taken care of in the course of a day thereby leaving precious little time for the reading of books under such "pleasant" surroundings, such being brought about only if you use this particular preparation.

Surely all of you can recall when not so long ago one of our national weeklies—a "must" reading in too many American homes—came out in its rather loosely conducted column headed "Medicine" with a review of an article advocating the use of a war-developed soap substitute, a detergent, as a new method of treating ulcer. Surely some must have seen patients who had read the article and decided to try it on their own and then came in frothing at the mouth and asking "why"? Leaving aside the Texas doctors' satire at our methods of handling ulcer, let us for the moment recapitulate some of the well known basic facts about ulcer defying the dislodging attempts of time.

Like every other phase in medicine our concepts as to the etiology and therapy of ulcer, if charted, would show a procession of peaks and valleys, illustrating how one idea reached its peak and acceptance, was tried and found wanting and sank into the valley of disuse and oblivion.

Since man first recorded his doings and his daily life by chipping away on stone, we possess a written record of ulcer and what was done for it, and at times this record has been truly fantastic and has run from the frankly ludicrous to the terribly lethal.

One or two of the hundreds of ideas advanced have been of some symptomatic benefit to the individuals involved. Some of the ideas have been propagated by well meaning crackpots with a crusading idea to do good in their own way for their suffering fellow men; some were prompted by a frustrated desire to get into print and into the limelight; others were there for monetary gain. Profiting as manufacturers by using the poor busy

general practitioner as a pawn, pharmaceutical houses have much not to be proud of.

If one stops but a moment and searches into the plight of the general practitioner, one will feel very kindly toward him and forgive him his errors. He is apt more times than not to be a purist and idealist; he has on his hands a stubbornly refractory case of ulcer which has not been doing well. Maybe the patient is a power in the community, influential and all that; maybe he is just plain Joe Doakes, but no doctor at any time wants to chalk up a failure if he can help it. He has tried all the orthodox methods but they have not worked out; so grasping at any straw, he has heard or read somewhere about this or that, so why not give it a whirl? He is desperate, his back is to the wall; he has not time to investigate for himself scientifically; besides he assumes that the investigating has been done by those advocating the regimen. The general practitioner far and wide has nothing to apologize for; the end is not even in sight; there will be more fads tomorrow and the day after tomorrow and not necessarily new ones either.

What of the patient? Inadequately informed and befuddled because of a spurious authoritativeness to each pronouncement, he has a long journey ahead of him through the school of trial and error. He finally arrives full of bitterness and rancor—an enemy of the physician and of the profession in general—misguidedly hoping that the doctor gets strung up by his heels in one of the socialistic schemes of practice advocated everywhere nowadays. It is a situation in which "you pay your money and take your choice," but there is no choice.

Delving into the history of the past, the earliest description of the symptoms of ulcer that I could find goes back to a manuscript dated 3500 B.C. I have to be exceptionally careful in these bibliographic references because I have medical friends interested in the same field and should one be in error I am very sure to hear of it.

My next reference is to the bronze and clay tablets of the Babylonian and Assyrian civilizations, from which museum experts have been able to decipher the hieroglyphics describing the daily life of the people. In one of these descriptions mention is made of "a passion of the cardia," a burning with a crescendo-like character climaxing in massive hemorrhage and death. That was the clinical course of ulcer as the Babylonians and Assyrians knew it.

From the Egyptian and Arabian civilizations which came after, only inferential evidence of their knowledge of ulcer can be found. Elaborate and detailed dietary directions featuring the use of mares and asses milk at frequent intervals and in liberal quantities are found. In all respects the diets recommended differ little from those we hand our ulcer patients today. When one progresses on to the Greek and Roman civilizations and reads of the orgies of gluttony, of the lustful, sensuous, satiating daily life, one is apt to think: how could these people escape having ulcers? But one reads further and learns that if you were in tune with the times and what the well dressed man or woman carried, you had your own private feather tickler; and when you were a bit uncomfortable and distended about the midriff, you did not have to leave the table. You summoned one of the attendants who brought a basin and then taking your wrought gold, filigreed silver or jewel handled feather you tickled your soft palate until up come whatever was bothering around the waist line and you turned right around and started eating again—strictly good etiquette. Then you stop to speculate and muse, surely there must have been plain, simple, common poor folk in Athens and Rome who never got to such feasts. What did they do? The historians do not tell us.

Although there is much in between, for purposes of brevity we pass quickly to the year 607 A.D. when one Paulus Aegaeus sat himself down and wrote a truly objective treatise on ulcer of the stomach,

its symptoms, his speculations as to causes and his approach to its treatment which included the use of clay or, in its more refined modern day materialization, kaolin or colloidal kaolin. So much for a minor deviation into the medical history of ulcer.

The patient who has an ulcer today looks around him and wonders why his neighbor can eat nails and he himself has difficulty digesting milk and he asks the medical profession, why? The profession to the best of its ability tries to answer that question on the basis of constitutional predisposition or its twin "ulcer diathesis" and in words of few syllables answers the patient. You were born doomed to have an ulcer and you would have had one no matter what you had done. The patient still bewildered again asks, why? The only answer available approaching rationality is that there is biological lack of integration or a hormonal imbalance within your blood stream; certain chemical substances are being overproduced or underproduced and these are acting by way of your nervous system or your glandular system to produce this ulcer condition. The patient still asks "why"? The very multiplicity of ideas as to cause only throws into the limelight what little we have to offer as to "why."

Only a few weeks ago I listened to a rapturous almost mystical discourse on the only logical cause of ulcer being an anatomic disarrangement of the normal relationship between the pylorus of the stomach, the superior border of the duodenum, the left lobe of the liver and the vertebral column, and verily I received the impression that the speaker assumed that such a theory was his own original brain-child unmindful of Cohnheim's enunciated same theory which has been kicked around for approximately the past hundred years. The speaker, with a chip on his shoulder, assumed the martyr's cloak and announced to his presumably experienced and educated audience that he did not expect to receive credit for this marvelous discovery during his lifetime, as history

showed that most medical martyrs were pilloried and crucified but that notwithstanding he was going to carry the cross.

Occasionally in gastrointestinal practice one runs across an extremely practical-minded engineer who has his own ulcer problem. Adhering to his engineer training, he has conducted a little independent research into his problem and comes up with the finding that we as physicians attempting to solve his problem have very little knowledge on which to go, and that much of what we have is confusing and not encouraging to even make a start on treating him. You see he has read everything or at least thinks he has. Accustomed to reducing all problems to mathematics, to the exact dovetailing of one piece of material into another, he vouches the opinion that perhaps we should call in engineers to help us, particularly in the field pertaining to materials. He believes that after some study as to gradients, position, etc., they might have something to offer. In retrospect it would not be difficult to agree with him; maybe he has something.

It has been not only a satisfying task but rather a stimulating one to review the literature pertaining to ulcer of the last fifty years, not to mention that it has been instructive as well. Following our stated pattern of peaks and valleys in the Fad and Fancy of the moment, it is amusing to see one method riding herd for awhile to the almost complete exclusion and extinction of all others, provoking reams of pseudo-authoritative writings in the literature, opining that at last we are on hallowed ground, that the problem of ulcer is no more. Then those inexorable judges come into the picture, "time and experience," and one notes that the literature on the "New Way" diminishes in a continued decline and gradually but completely sinks into oblivion. Surely there must be some red faces among those authorities if they go back and read some of their cocksure enthusiasms which even they themselves have long discarded from

their therapeutic armamentarium. One feels much in sympathy with old Hieronymus Cardanus who threw all his medical books out the window and announced to the world at large, including his scientific brethren, that he was henceforth practicing medicine in the light of his experience and not from written dogma.

One could be amused at the rise and fall in popularity of these "new methods" and regimens, so similar to the stock market averages or milady's fashions, were it not for the fact that the victim of these vagaries of some and downright idiocies of others is a suffering human being who without being consulted is being used as a guinea pig and who has had imposed on him willy nilly a succession of outrages; and outrages some of the suggested methods surely are. Caught invariably in the middle of a succession of controversies, he alone suffers the pain and puts up with the disability until a new wave comes along and the experience is repeated. There has been a feeling abroad everywhere in recent years that one should never criticize unless one has a constructive solution to offer. This dictum was the illegitimate offspring of political expediency, badly needed by its exponents to cover up their own malfeasance. In medicine it can never be other than helpful to ourselves and our patients if we analyze our own follies and foibles, even if the only profit from doing this is that we shall not commit them again.

As an example, it was not in any spirit of criticism that this review of the literature was made; it was truly an altruistic interest in the opinions of outstanding medical authorities on this subject and also of others not so outstanding. Then as the incredulous recommendations of these men came to the fore, there came possibly the conviction of a crusader, that if our erratic aberrations were brought face-to-face, confronted resolutely, we might all benefit thereby, patient and physician alike, the former by not having untried nostrums foisted upon him and the latter by having his eagerness to accept all too quickly any

untried theory curtailed. The author recognizes the fact that in many many cases this all too prevalent eagerness is born rather of desperation and of honest endeavor in trying to help a patient or patients.

In the literature of the past fifty years covering the etiology and treatment of peptic ulcer one finds forty-six different regimens in therapy recommended, eighty-nine different pharmaceutical preparations recommended, nineteen non-pharmaceutical preparations and fourteen etiologic theories and concepts as to cause. The very multiplicity of methods advanced for treatment is proof of the efficacy of none. Once again, to recapitulate and to apologize, the purpose of this paper is not to criticize; its only purpose is to look backward. If by looking backward we can learn enough about past perpetrated follies so as to incite in each of us a keener scrutiny into the theories advanced in our own time before they make the uninformed headlines, then we have indirectly helped countless numbers of ulcer sufferers. Having adopted a stand that it is entirely without criticism that our past follies are paraded before us but that it is done in an earnest desire to prevent these follies in the future, let us do as the statisticians do and break down the figures presented.

#### THEORIES OF ETIOLOGY

*Mechanical.* There are numerous and sundry variations of the old Cohnheim theory regarding pressure exerted on the stomach and duodenum by the left lobe of the liver pressing these organs against the vertebral column in a sort of squeeze play. The trauma so produced is supposed to cause terminal emboli and/or small hemorrhagic petechiae which ulcerate, then enlarge into true ulcers. This theory did not originate with Cohnheim. It can be found in Galen's works and, inasmuch as there is much evidence that Galen was a copyist, he may have lifted the idea from somebody else. This theory was the basis for the occupational disease etiology of

ulcer and its questionably high occurrence in shoemakers. This theory was brought forth again in 1946 and 1947, refurbished scarcely any and advanced by its proponent as "new."

*Infections.* There could scarcely be anyone who is not familiar with Rosenow's theory of focal infection, particularly a specific streptococcus which could be obtained from dental root abscesses, sinuses, tonsils, et cetera, and which when injected into a guinea pig produced shallow, punched-out ulcers in the pylorus, lesser curvature or duodenum. Rosenow's theory carried the name "elective localization of bacteria."

Although Rosenow's theory has fallen into oblivion, we have had a newer version of it published in the *American Journal of Medical Sciences* in 1945. The title reads, "Peptic Ulcer Produced by a Specific Organism Fulfilling Koch's Postulates." There was also a proponent of a particular strain of *B. Welchii* as a cause. Similarly there was also a proponent of a strain of staphylococci as being causative. Laboratorily we find one man producing ulcer by the intravenous injection of strains of *Staphylococcus pyogenes* in rabbits. One man went so far as to advance a thrush fungus as etiologic. Offshoots of the above infectious theory have been advanced as causative, e.g., mechanical changes in the direction of lymph flow from the ileocecal area, particularly if the latter area is in a state of either irritation or inflammation, low grade or otherwise.

*Constitutional Predisposition.* This theory covers a multitude of angles, such as that ulcer is apt to occur more frequently in certain families and that one can chart the incidence of ulcer in these families in such a manner that heredity can be advanced as a factor in etiology of ulcer. It bulwarks the beliefs of those who believe in "ulcer diathesis." Diathesis is used to designate a presumed biologic or physiologic change in body chemistry in such manner that in any individual in which this is present it would manifest



itself in the form of an ulcer. Heredity, familial tendency and diatheses act either alone or as helpmates to each other in varying undetermined degree to bring about their materialization as peptic ulcer.

*Endocrine.* Here exists the opportunity for a wide play of factors. The theory of deficient thyroid activity and hypotonia—myasthenia gastrica—probably both directly and indirectly is associated or is a part of the theory of “fatigue hypotonia” or “fatigue atony” as a cause of ulcer. This covers also the tired business man and why he gets ulcers. Overactivity of the thyroid with spasm of gastric musculature, the direct opposite of deficient thyroid action is also advanced as etiologic and is presumed to produce by said spasm arteriolar emboli which break down and become necrotic. The slough leaves a small ulceration which enlarges and becomes a true ulcer. Again it covers our tired business friend. The concept of overactivity and of underactivity of both the anterior lobe or of the whole pituitary gland are advanced in exactly the same manner as in the case of thyroid etiology.

The literature did not disclose any one advancing hypo-adrenalinism as a cause of ulcer although the proponents of the hypotonic and gastric muscular atony theories certainly could or should have injected some part of the concept of hypo-adrenalinism into their theory, in my belief. Nor did any reference mention ulcer in Addison's disease. When it comes to hyperadrenalinism, however, the story is different. In here comes the theory of “The Kinetic Drive” ulcer, a disease of the Phi Beta Kappa's, of the hard driving business man, therefore, reduce his drive, excise his adrenals. How many patients had an Addison's syndrome to contend with on top of their ulcer we were never told. One wonders were there any postoperative sequelae in the form of malpractice suits. We were never told. What of the moral and intellectual integrity of individuals who, misguided and under the cloak of pseudo-authority, perpetrate the imbecilities of

an arteriosclerotic upon their unsuspecting fellow men?

Nobody has had the effrontery to advance any prostatic change as the cause of peptic ulcer except indirectly. Rosenow in his theory of focal infection did call attention to it. The citation of all these theories dealing with the pathogenesis of ulcer is admittedly exhausting, but it cannot help but serve some purpose if even only to bring the reader up-to-date on medical bibliography. When one counts and finds that in the past twenty years 550 articles have been published pertaining to the etiology and pathogenesis of ulcer alone and that as a specific illustration the high peak, when estimated by years, was in 1922 when thirty-six articles appeared devoted to this one phase of ulcer alone, one gets an inkling into the enormity of the writing which has been done.

*Allergy and Amebiasis.* The proponents of specific protein sensitization of individuals with their histamine and anti-histamine factors playing a rôle have been able to make out a very plausible theory. The seasonal frequency of activation of acute ulcer symptoms falls indirectly into this same field of allergy and has been brought forth as another spoke in the wheel of evidence for the theory. Once again the name of Cohnheim enters the picture as he in reality first advanced this idea of seasonal recurrence.

Scattered here and there in the literature at about five-year intervals certain individuals have endeavored to tie in peptic ulcer as a part of an intestinal amebiasis and then have apparently been quite intrigued with the thesis of *Amoeba histolytica* acting as a causative agent.

*Miscellaneous Causes.* Several minor etiologies involved are venous stasis and colloidal diffusion. Theoretically, if one follows this theory in its natural course, cases of cirrhosis of the liver, passive congestion of the heart and chronic Bright's disease should feature peptic ulcer as a prominent accompanying syndrome, but clinical experience does not corroborate this.



Relative to trauma, other than Curling's ulcer of the duodenum following severe burns, the mechanics of the production of which are quite foggy I believe, it would be difficult to find many men willing to agree upon direct trauma as an instrument in the production of ulcer.

In the case of tuberculosis the proponents are confusing the issue and talking of a tuberculous ulcer of the stomach. On direct questioning of present day leaders in gastrointestinal work, none has ever seen and most pathologists readily admit that they, too, have never seen one.

Improper eating habits, excessive smoking and alcohol are mentioned occasionally. Such factors as the hurried bolting of food, the eating of foods either too hot or too cold, overindulgence in highly seasoned and highly spiced foods should, in the light of our present day knowledge, be considered in the light of contributory rather than as directly causative. In the same category we would place smoking. Clinically, it is unusual to find heavy drinking and ulcer associated, possibly because, does alcohol not have a more hardening or tanning action?

*Neurogenic.* Under neurogenic etiology it is not out of order to include two subclassifications, not in any manner depreciating them into minor as they are major. In the *psychic* type we have the neuroses, neurasthenia, hypochondria, post-traumatic neurosis, hysteria and psychosomatic problems. The sympathetic or autonomic type of etiology is based mainly on a concept of vagotonia as productive of ulcer. This was aided and abetted by the discovery in the laboratory animal that electric irritation of the vagus nerve can be caused to produce an ulcer.

It is customary when speaking of the part played by the nervous system in ulcer production to stress the anxiety neurosis based on fear, emotional distress, et al. The psychosomatic group have apparently appropriated this field and therefore a discussion of it falls more naturally under that head. Suffice it

to say that vasomotor disturbances in these anxiety neuroses manifest themselves as palpitation, vertigo, dizziness, dyspnea, diarrhea and epigastric distress. Neurasthenia is an old timer as terms go, high lighted by and in the days of Wier Mitchell. It is rather a vague term and has always been used in rather an elastic manner to cover a varied symptom complex. These patients have certain things in common in addition to their epigastric distress and ulcer simulating symptoms. Common to almost all are a low threshold of adaptability to the realities of life, a high degree of emotional instability, extraordinary and unaccounted for fatigue and either a fairly true migraine syndrome or a pressure band around the head.

There have been attempts by some to name hypochondria as a causative agent in production of ulcer. This is entirely in error. It is true that hypochondriacs do have ulcers—coincidence purely—and it may be true that an ulcer makes a hypochondriac of an individual. It is very necessary that we evaluate properly all neurogenic influences associated with ulcer and assign to each its proper place. In the future we are going to see more and more of these patients as they drift away from the care of the Veteran's Administration. Hypochondria is truly neurosis-somatic in type. The individual pattern of conduct, whether male or female, is that of a transference of attention to the stomach, an intense pre-occupation with some bodily organ—in this instance the stomach—although minute detailed study will reveal no pathologic deviation from the normal in even the slightest degree. A hypochondriac's interest, instead of being centered externally upon the world around him and adjusting himself to it, becomes centered in himself and in his body. His complaints are subjective. As these intensify because he does not seem to find relief, a certain amount of psychic elaboration takes place and he becomes a very sick man. In my opinion the best approach to treating this individual is to

go along with him, agree with him that to all intents and purposes he had an ulcer, distract his attention from his ailment to his dietary regimentation and his hourly schedule of medication with occasional assurances that progress is definitely being made.

We can dispose of the post-traumatic neurosis as an etiologic factor in production of ulcer by saying nobody has offered the slightest evidence warranting such an assumption. If ulcer occurs in such an individual, it is by sheer coincidence. He or she who develops an ulcer after trauma, severe or otherwise, must have other factors contributing to such production. Possibly the psychic conflict with regression and failure at adjustment or restitution of one self into society may contribute indirectly to whatever biochemical, physico-physiologic unbalance is necessary.

Hysteria is definitely not etiologic. It is merely a psychic disturbance which can manifest itself by simulating any sign or symptom of organic disease. These states are an aftermath of war and it will be our experience to run across not a few but many.

More recently a psychosomatic theory has been evolved as to an etiologic factor in ulcer. I do not consider myself as competent to judge here. I can only illustrate my attitude by the following experience.

About twenty years ago it was quite the mode for our psychiatrists and psychologists to go to Vienna for experience at the fountain head of certain branches of their science. Invariably these men became involved in mental and extramental problems and separations of former well meaning husbands and wives took on epidemic proportions. Not long ago I attended a seminar on the psychosomatic approach to ulcer. As the session was closing several men asked me for my opinion. It was easy to give: If you believe whole heartedly in what you have heard, your handling of an ulcer case becomes

almost unbelievably easy. You simply tell your patient, they must either chuck their job or chuck their wife or husband as the case might be. It would be amusing to watch somebody else handle ulcer cases in this manner and to see how long they had patients coming to them for such handling.

At the last meeting of the A. M. A. in Atlantic City, toward the end of a session when discussion was thrown open to the assembly at large, a doctor indicated that he would like to speak. There was much noise as scores were leaving their seats. Finally, the individual launched into an exposition of his own ideas, namely, that if people lived and upheld the Ten Commandments there would be no need for vagotomies, partial or subtotal resection and what have you. The applause was more than any other speaker had received.

I do not want to leave this subject of etiology of ulcer without at least referring to Harvey Cushing's observation that he thought there might be some thalamus or hypothalamus association in etiology. Inasmuch as our information as to the physiology and function of these brain areas is meager, nothing is to be gained attempting to discuss it.

#### THERAPY

The patient has suffered both directly and indirectly as the result of prejudice and lack of knowledge as to etiology; but when we delve into the realm of therapy, the patient has truly experienced hardship, misfortune and insult.

Not long ago A. C. Ivy estimated that in any ten-year period of life in America it could be counted on that one and a half million people would develop ulcer. If each of these patients is to experience hardship because of variances in opinion as to therapy, honest though they may be, the sum total of trauma to be expected is truly awesome.

A count of all the methods of treatment proposed for ulcer since 1900 shows forty-six different procedures. In 1947 a new

treatment was reported for ulcer sufferers. The patients could eat good nourishing food instead of "baby foods" provided they took a combination of mucin and aluminum magnesium trisilicate in palatable form. How many recall "mucin therapy" when patients esthetic sensibilities were violated but they took the stuff because they wanted to get rid of their pain.

Another recommended agent, new, right hot off the griddle, composed of "insoluble alkalies." They do not tell you which ones because after all its new. We have not been talking about insoluble alkalies much more than fifteen years. Why does it act better than anything else ever promulgated? Because the fellow who got this one up, got to "thinking," yes, sir, actually "thinking" and he came up with the answer: This product controlled the acid in the duodenum—yes sir.

Another one is colloidal aluminum hydroxide and magnesium tri-silicate. There are fourteen more like it but each has a different name; all unanimously set out to produce one thing above all others, palatability to the patient.

Intramuscular injections of protein free pepsin, daily for ten days and three series of ten injections each, have been advocated. The advocates of histaminase therapy based their work on histaminase neutralizing histamine action thereby lowering the gastric acidity. If there was an allergic basis for ulcer, histaminase here again neutralized the action of histamine, the basis factor involved.

In another authoritatively written article the "acid-pepsin" factor in gastric and duodenal ulcer is emphasized. It goes on to say that 75 per cent of all patients with gastric ulcer and 20 per cent of those with duodenal ulcer have low or normal acid values in the stomach while many people who show high acid secretory curves have no subjective or objective evidence of ulcer. The article stresses the continuous neutralization of acid particularly at night wherein it is said the Sippy and other regimens take no cognizance of the pres-

ence of highly concentrated acid in the stomach at night. It is recommended that the patient empty his own stomach before retiring. Much depends on the patients being able to acquire a "tube technic" as the intubation is more or less left entirely in his hands. These authors must have had unusually cooperative patients whose esthetic threshold was low. Otherwise how could they perform functions all day and night with a tube hanging out their mouths as recommended.

We have many types of "gels," aluminum phosphate gel being most popular or aluminum hydroxide with ingredients added here and there, usually non-absorbable antacids to augment or counteract certain features of their action.

Many an observer in this particular field of gastroenterology has tried to establish a certain facies and physiognomy as typical of the ulcer patient. I quote from a description: "Ulcer occurs in thin, high strung, lantern jawed persons who work hard, worry excessively, and are introspective." Peculiarly enough during a respectable span of years in this field I have never come across the lantern jaw with an ulcer. Possibly mere coincidence and I have been avoided by the lantern jawed, but you can get as many different descriptions of the presumably facial contour of these patients as you have time to dig up the literature. This theory or supposed theory went into total eclipse some years ago.

The curious phenomenon of all the advocated therapies for ulcer is that one individual will advocate one theory and another individual advocates the direct opposite as producing exactly the same effect. The injections of protein free pepsin as fostering healing with cessation of symptoms is advocated in one article, but in another article the author advocates using anti-pepsin injections and wants to go on record as obtaining the best results.

To return only briefly to the advocacy of a physiognomical type as particularly susceptible to peptic ulcer, another group of observers stress the hereditary and

familial occurrence of ulcer or, as they express it, the heredo-familial tendency to ulcer. In enlarging they offer an "ulcer personality"—"a restless, aggressive individual, possessed of great excitability and enthusiasm, involved in one emotional cause after another, dependent on the success or failure of his 'drives' in the field of economics, love and living.

Some years ago the writer published an article on the possible rôle of the thyroid in peptic ulcer, endeavoring to find but with little success a scientific basis for that which we untuitively sensed. Since then and before we have had numerous ductless gland products administered to ulcer patients with reports of success in healing. There have been pituitary extracts—anterior, posterior and whole gland. One attributes ulcer to a parathyroid deficiency and advocates replacement therapy, e.g., liver in pernicious anemia, thyroid in myxedema, etc. One reports having given 1 cc. of parathyroid extract injections at varying intervals and mentions sixteen years of success.

A Naval Medical Bulletin publishes an article in which desoxycorticosterone injections were given but concominantly the patient was placed in bed on a Sippy regimen. Instead of crediting the Sippy regimen with some influence in the disappearance of the ulcer crater, through some process of reasoning the author prefers to credit the desoxycorticosterone. Only a few years ago one man was reporting bilateral adrenalectomy as a cure.

Three authors used posterior pituitary extract; 15 to 30 units (international) of pituitrin was given daily in divided doses for seven to fourteen days based entirely on an observation that a moderate polyuria and nocturia had been observed in cases of peptic ulcer and that the mechanism involved might be the same as in diabetes insipidus; therefore, posterior pituitary extract was indicated. There is no questioning as to whether this polyuria, which is recorded in the report as mild, might not have been due to whatever regimen the

patient was following prior to pituitary therapy. This previous regimen might have had a high liquid content in the form of milk alone. In addition there was no questioning as to whether the patient was taking alkalis and what type of such, as alkalis often cause a frequency and polyuria; there was no checking or rechecking but a rush into print with results in seven cases. This was followed two years later with experiences in forty-two cases. In this latter report the original therapy was augmented by nasal insufflation of posterior pituitary extract and this was advocated as a "New Method."

A very well known gastro-enterologist discussing sex hormones and peptic ulcer observes that pregnancy has a beneficial effect upon ulcer because symptoms of ulcer are exceptionally rare during pregnancy in his experience, and in addition that the symptoms of ulcer in women tend to be aggravated during the menopausal period. Assuming these facts to have some involvement or relationship to a pituitary-gonad-thyroid mechanism, this observer gave to an equal number of men and women with ulcer fourteen daily injections of antuitrin S either subcutaneously or intramuscularly and then tabulates his results, arriving at a conclusion that 61 per cent of his patients were symptom-free at the end of fourteen days. Gastric analysis during and after treatment showed no effect on either the free or total acid secretion. The conclusion finally arrived at is that the urine from normal persons contains a protective factor against ulcer formation in rats and that in the urine of patients having ulcer this factor is absent.

However, if one reviews a considerable amount of the literature on this subject of ulcer, and presumably the same applies to almost any medical or scientific entity, one cannot help being struck with the repeatedly same pattern of thinking. It follows definitely Pavlov's theory of the conditional reflex in its sameness of pattern although there may be long intervals between individual pronouncements.

Remembering how Pavlov trained his white mice so that at a sound, with a definite pitch not one iota above or below, the mouse started for his dinner, this same conditioned reflex can be transposed into human conduct, specifically in the entity we are discussing. Over and over again we meet with repetitive conduct, reasoning and advocacy in the treatment of ulcer.

A gastro-enterologist of wide experience noted the rarity of peptic ulcer and also the extreme rarity of acute perforation in females as experienced or demonstrated by his hospital records. This fact corresponds to the initial idea from which he deduced that the ovary or testicle might secrete some protective material against ulcer, therefore, he gave ovarian extract to his females with ulcer and, transposing this analogy into male, gave them testicular extract, whereupon he immediately published a paper announcing success for his brainchild.

The above has been rather a boring résumé of the highlights only in the hormonal or endocrine approach to the ulcer problem both from the etiologic and therapeutic standpoint.

Exactly the same type of conduct and experience prevails in the field of vitamins. Every vitamin known has been advocated as a palliative or cure for ulcer on the basis usually that there exists in the individual having ulcer a definite deficiency of that particular vitamin. After some years of trial and error the fallacies of these types of thinking glare fearfully in their barrenness and a bit red-faced the profession drops them quietly into the limbo where they belong. With no other objective than that the record shall be more or less complete, mention and mention only will be made of other methods of therapy which for one reason or another have occupied the center of the stage for an interval of time. It was with a great deal of surprise that on a recent program of a national medical society one heard a foreign clinician,

whose name is known to any American in this same field, discuss, apparently in all sincerity, the benefits of deep x-ray therapy in peptic ulcer, an idea which time and experience have exploded as a complete fallacy. It is recalled that years ago this same individual handed a bag of calcium carbonate to every patient in his clinic whose condition was diagnosed as ulcer, and very frequently the diagnosis was not corroborated by x-ray. The patient was told to carry it always in his pocket and that whenever he felt any epigastric distress he was to take "about" a teaspoonful or take the same amount every two hours. If the clinician's present advocacy of roentgen treatment has been arrived at in a similar slipshod manner as his therapy of former years, why is such an individual even allowed to air his opinions before an organization of presumed sound scientific and medical integrity? Since starting to write this paper, the roentgen therapy of ulcer is again being recommended, this time from an American clinic.

At another very august meeting of a very august society one of its members promulgated the use of histamine injections as of therapeutic value on the basis that, although histamine did provoke high acid values, it had the faculty of opening up constricted vessels in the body, therefore in the stomach. No mention is made as to whether or not this same faculty or property (the latter word is more pertinent) could not contribute to possibility of hemorrhage from an ulcer.

Another learned scientist, a laboratory biologist not a physician, is able by his pet theory to blame the suprarenals for gastric ulcer and the thyroid for duodenal ulcer. His theory involves an excess of iodine in the body which, when already high, is further augmented under emotional stress by iodine released from the mid-brain, a powerful storehouse of iodine, and from the pituitary, parathyroid and thyroid glands. Excessive amounts of iodine and chlorine may cause a breakdown of the gastric mucosa and lead to ulcer

formation. Mention must be made of the use of ingested antiseptics as a method of treatment. Usually these antiseptics were of the dye family—metaphen, merthiolate, forms of violet dyes. Their use was based on the fact that they overcame perulcerous infection which was presumed without proof to be always present. They are mentioned only in a historical attitude as they were a fad of but only a moment. Scarlet red, another dye, once recommended should not be omitted. In similar manner must one refer to the injection of sodium citrate solution intravenously and also of hypertonic salt solution.

At the present time we have new actors hogging the stage, two medical and one surgical. Unfortunately for the medical agents, who arise from well accepted and orthodox sources of unquestioned integrity, they first hit public attention by way of lay channels, namely, the non-medical press. Ulcer patients by the score approached their physicians with copies of these newspapers and periodicals with the query—"Do you know about this? Why am I not getting it if it will cure ulcers like it says here"?

I refer to the recently announced theories: (1) split proteids orally in large amounts and (2) enterogastrone. One daily newspaper noted for its conservative approach to all things makes the announcement of enterogastrone thusly and I quote from a clipping: "A hormone extracted from the intestines of newly killed hogs has *proved helpful* in curing peptic ulcers of human beings by injection into the muscles." Here again comes that constantly recurring paradox to the fore. Enterogastrone was first isolated in the laboratory of Dr. A. C. Ivy some years ago. I recall at the time writing to Dr. Ivy and his letter of reply was conservative and orthodox-ethical, but note the manner in which the press gave it out.

When we speak of a paradox with reference to enterogastrone, it is for the reason that enterogastrone is probably a chalone or an inhibitory antacid, whose

function is to inhibit gastric motility and secretion, whereas mention has been made of the advocacy by some of injections of histamine substances in the therapy of ulcer. As a by-product of Ivy's enterogastrone investigations we have an explanation of a phenomenon which we had all observed in ulcer cases, namely, that a high fat intake reduced gastric motility. Ivy demonstrated that when undigested fats come into contact with the fat sensitive portions of the upper intestinal tract, an excess of enterogastrone is excreted and its inhibitory action on gastric motility and secretion takes effect. The fat itself has no inhibitory powers; it initiates a demand for increased secretion of enterogastrone. More recently we have had much about urogastrone thrust upon us.

Up to the moment we have dealt mainly with the fads and fancies of the medical approach to the ulcer problem. The surgical approach also had and is having today some of its own folderol falling into controversy and not emerging too cleanly washed of some of its sins. The first operation for ulcer came into being as the result of sheer necessity and had the good fortune to meet up with a personality possessing sufficient ingenuity and daring to formulate a plan and act on it. The first gastro-enterostomy was done in Vienna at Billroth's clinic by an assistant named Wolfler.

These initial gastro-enterostomies were done not particularly with anything in mind toward healing an ulcer but mainly to relieve an accompanying pyloric obstruction. Indirectly it was hoped and later staunchly advocated that by keeping the ulcer area free from contact with the food column an optimum condition for healing was obtained and that, therefore, the ulcers did heal.

As might be expected following such an announcement, there was a violent wave of doing gastro-enterostomies all over the world and in similar manner all over the United States. The operation was not too difficult; the technic was easily mastered

and the mortality rate even in questionable hands was not too high. What was lacking was proper selection of those who did not do well following gastro-enterostomy, and laying down a formula by which one might be able to prognosticate which individual was a probable candidate for a quick recurrence of his ulcer and which not. Experience was that elderly people fared best with gastro-enterostomy both from the standpoints of mortality and recurrence. Young people did not fare so well as regards recurrence, and here we must use that phrase which is hackneyed, particularly the hyperkinetic type.

In no time at all after posterior gastro-enterostomy took its place in the armamentarium of the abdominal surgeon the technic of anterior gastro-enterostomy came flashing over the surgical world and many were the advantages initially claimed for it.

Time and experience evaluate all these things coldly and soon their value finds its proper level in the scheme of things. Some surgeons prior to gastro-enterostomies had made attempts at local excision of ulcers with rather indifferent results so that it was almost inevitable that there should exist a sort of psychic barrier to merely by-passing an ulcer without any direct attack on the ulcer itself. Therefore, the next step in the evolution of the surgical approach was local excision coupled with gastro-enterostomy, usually posterior.

Following this came a wave of attention directed toward the pylorus. On the surface it would appear that any surgeon of any prominence originated some type of plastic operation on the pylorus. Almost all these technics were designed to facilitate easier emptying of the stomach.

At about the same time a wave of exclusion operations was born, Eiselsberg, Devine, et al. In this wave a duodenal ulcer was or was not resected according to ease and operative risk. Between a double row of sutures across the pylorus complete separation was made by cutting the ends folded in by serosa to serosa

suture on the gastric side and the pyloric side. In such manner it was made certain that food could not possibly get to the ulcer area as it was doing in so many gastro-enterostomies in which food continued in its old way of passing out of the stomach by way of the pyloric canal into the duodenum instead of passing through the new stoma.

Also-called "gastro-enterostomy disease" which was plaguing surgeons also appeared. It was the result of a vicious cycle wherein food would play around that portion of loop between the new stoma and pylorus. Often antiperistalsis came into play and food would pass up and down this loop, regurgitate into the stomach then through the stoma back into the stomach and pass out again through the pylorus, a very regrettable state of affairs particularly to the surgeon involved. To try to correct such a state of affairs was the reason for the birth of all the exclusion types of operative procedure. They created a blind end at the duodenum; food could go no farther and there was only one exit from the stomach, not by way of the pylorus but via the new stoma the gastro-enterostomy had created. While all this was going on, many men dissatisfied with their results with gastro-enterostomy were playing with the idea of resections of the stomach sometimes including the ulcer when it was feasible, but these procedures were applicable only to gastric ulcers and then only if the ulcer by chance was in a particularly accessible area anatomically and surgically.

In 1896 came Billroth's pronouncement of his Billroth I and Billroth II type of gastric resection. This was a milestone in the history of gastric surgery in spite of the fact that there are detractors who claim that Billroth was not the actual originator of these procedures, that he has seen them done by somebody else, that he adapted them as his own and that he was in a position to shift all credit and publicity to himself.

The difficulty with the anastomotic



types of operation was that they did nothing to reduce gastric hyperacidity and hypersecretion, particularly night secretion. These Billroth procedures filled the gap because they featured and emphasized the taking away of all or almost all of the acid-secreting portion of the stomach.

On the heels of this a flood of modifications of the original technic came almost immediately. More or less only two have survived, the Hofmeister-Finsterer technic and the Polya, whole-width anastomosis of stomach with jejunum.

The many plastic procedures in addition to the multiple tricky resection modifications have died unsung and unheralded. What has survived has done so because of some measure of human value over the years.

For approximately the next forty years the surgical pot simmered slowly with little or nothing happening to disturb its equilibrium. Meanwhile, the medical men announced another fallacy, namely, the treatment of peptic ulcer by means of rectal instillation of sugar solution. The surgeons announced opposition to any such extensive procedures as subtotal gastrectomy with its high mortality for such a "simple" thing as an ulcer, but total gastrectomy for that ulcer high up on the lesser curvature was a different matter and was O.K. A few even recommended going back to an old procedure which existed prior to gastro-enterostomy, local cauterization of the ulcer. Another advocated a dorsolumbar sympathectomy based on Cole's work with the sympathetic of this area.

Duodenectomy, pylorectomy, fundusectomy and oblique gastroduodenostomy all came into the lights, took a bow and then went back stage into darkness.

The wave of popularity and enthusiasm for gastric resection particularly in Europe supplied abundant material for histologic study. Based on this tissue study, out of France and Germany was born the theory that a gastritis, hypertrophic or ulcerating in type, was the forerunner or underlying

factor in the pathogenesis of ulcer and that on this basis its chronic course and its remissions and exacerbations could be explained; they denied the importance of the pepsin-hydrochloric acid factor in ulcer.

About twenty years ago Eppinger in Vienna suggested that vagotonia provoked spasms of the muscularis and of the muscularis mucosa, leading to areas of ischemia which favored formation of erosions and ulcers. A spastic condition operating on the end vessels in these two layers was a possible predisposing cause. This led to endless experiments on the vagus nerve and on extirpation of the sympathetic and celiac plexuses; but in the laboratory the results of these experiments were entirely too contradictory and, therefore, the theory was laid to rest. Now it has been brought forth anew, polished up and occupies the center of the stage this year (1948). Also along in the early 1920's the vagus nerve was occupying the attention of various laboratories throughout the United States. From some laboratories came reports that stimulation of the vagus nerve could be made to initiate ulcer lesions in the laboratory animal; from other laboratories came word that section of the vagus, anterior and posterior would cause ulcerous lesions in animals—again the oft repeated formula of "paradox."

Here and there, particularly in cases of gastric ulcer high up in the stomach where the operator was working in almost the immediate vicinity, an occasional section of the vagus nerve was done. At times it was only the anterior portion of the nerve which was cut due to accessibility; then some men wanting to satisfy themselves better as to what could be accomplished sectioned both the anterior and posterior branches.

However, it was not until the past two or three years that, due primarily to the lay press featuring the dramatics of any situation, the message has been taken to the lay public that here is the "miracle operation" so long awaited, here is the last



word on ulcer; there need be no more suffering; this is it. So once again the ulcer patient in the rôle of a cash customer gets on the ferris-wheel to be lifted to dizzy heights of expectation and then the wheel turns downward and he is on the ground again, a soberer individual, feeling that all is not exactly as it should be, that maybe he has been taken. The press goes on and repeats this performance over and over. Memories are short. Nobody seems even to remember the part played by this "miracle operation," but the doctor and the medical profession get an extremely large and very deeply discolored eye.

One of the functions of the vagus nerve which arises from central nuclei in the brain stem is the conveyance of the sensation of pain from several organs in the upper abdominal tract, specifically the stomach and duodenum, to the brain. The pain experienced by the ulcer patient when there is activity or irritation about his ulcer or when the raw base is bathed in a concentration of hydrochloric acid or mechanically irritated by food brushing over it is at times frightfully severe. One of the almost consistent advantages claimed for vagotomy, the miracle operation, is that it immediately gives the patient relief from pain. There is room for argument here as to whether or not relief of pain *per se* is a most desirable thing if the underlying factors involved in the production of pain are not taken care of. True it is not an identical analogy. But is the relief of pain in angina pectoris by way of sympathectomy entirely a desirable situation? Evaluating human conduct and its aberrations with a cold jaundiced eye, freedom from pain sensation could more often than not create a false psychic euphoria, and patients are more likely to overstep their dietary limitations with more or less disastrous results to their ulcer condition. It occurs that it would be of interest to observe in patients who have had vagotomy whether there is any higher tendency toward postoperative hemorrhage or perforation, and by postoperative

is meant not immediately but some time after operation.

There has been a tendency to overlook entirely the fact that the vagus nerve plays a part in pancreatic function, in liver function and in upper colon kinetosis. To date no work has appeared in medical journals with regard to postoperative upsets in carbohydrate or fat metabolism following vagotomy. One or two papers have remarked as to the disagreeable feature of epigastric and upper abdominal fullness due to the protracted delay in emptying time of the stomach because the propulsion or peristaltic muscular contractions have been interfered with by upsetting the normal physiologic rhythm through sectioning the vagi.

In all of nature there is an interlocking or integration of physiologic processes, and no work has as yet come forth to show that the stimulus in the mid-brain comes from food intake, sham or otherwise, that it is transmitted by way of the vagus nerve to the secretory mechanism of the stomach calling for just so much and no more of pepsin and hydrochloric acid and that this brought about a stage of digestion which at a certain point causes the pyloric sphincter to relax and the food to pass into the duodenum. Even Pavlov in all his digestive experiments was unable to answer both the quantitative and qualitative riddle of this outpouring of digestive juice, particularly what controlled its selectivity or what directing mechanism controlled the pouring forth of large amounts of pleasurable juices to take care of a thick steak and such small amounts to moisten only a teaspoon of sand. Such is the economy of nature and the physiologic integration of our processes of living.

It comes out now that in cases in which vagotomy has been done some men are having trouble with an atony and dilatation of the upper colon, an idiopathic dilatation of the colon with its bloating, distention, fullness and discomfort. So the patient has swapped his pain, which told him to take a glass of milk with or without

some alkali, for an uncomfortable readjustment of his belt. The vagus nerve being cut, no pain sensation is transmitted to his brain but he can look down and see a pregnancy-like ballooning of his abdomen and he does not like it.

Some measure of relief in the above can be expected possibly by combining vagotomy with gastro-enterostomy. This would provide a mechanical exit of varying degree of function, but would do nothing toward the digestive process to reach the point where active propulsive peristalsis would push the food out of the stomach.

Due to the lowered acid secretion in the stomach following vagotomy persistent diarrhea has been a complication in a number of cases. True, some have cleared up after a time and without medication, but others have been protracted and troublesome. What irony if only the administration of free hydrochloric acid will relieve this diarrhea in a patient who formerly manufactured his own free hydrochloric acid and who after an operation to obliterate his capacity to do so finds that he must take synthetic hydrochloric acid to relieve the very symptom he substituted for that of his ulcer.

De Muth, of Vancouver, makes a very pertinent and timely point with regard to postoperative disadvantages of vagotomy. At this very moment wherever one chooses to look—street cars, bill boards, store counters—one sees the admonition, "One in eight will die of cancer." If one gets the daylight scared out of them, they will pick up a leaflet and the leaflet tells them that at any sign of pain or discomfort they should see their doctor. The vagotomized patient will be unable to do this as far as his stomach is concerned because he is free of the sensation of pain from the region of his stomach, and he will not know whether anything is going on or not. If he develops a new ulcer, a carcinomatous change in his former ulcer area or an actual carcinoma, he will go blissfully along completely unaware that all is not well within. When other signs or symptoms do come

along warning him or the physician, it stands to reason that it is probably "later than you think."

De Muth also warns that vagotomy is so permanent. Unlike some operations on the stomach it cannot be undone. What price this, if later it should prove from experience that it, too, was but the star of the moment in the play of fad and fancy. The question which will come up sooner or later before the bar of sound medical opinion will be, Is vagotomy a miracle or is it a disaster?

At one of our recent national medical conventions a great surgeon told his audience of medical men that two of the great faults of medicine, among others, were prejudice and lack of knowledge. In his opinion the latter was very evident in what we were doing about vagotomy. In his words, "vagotomy is a very desirable thing if it has no price." There is entirely too great a depth to the wave of enthusiasm for vagotomy; it was the same in the beginning of gastro-enterostomy and gastrectomy. The late or end effects of vagotomy on the histology and physiology of the adrenals, kidney, hormonal system have as yet not been evaluated. The surgical handling of the problems of hemorrhage and perforation following vagotomy are entirely without the scope of this paper.

Keenly aware that what is an absurdity and to be laughed at for the people of one era may become the scientifically proved dogma of a later generation, and grasping at the reasonable assumption that all men in the field of medicine are concerned only with the betterment of their fellow man, it is reasonable to assume that men of much more than average intelligence should advocate only that which they would choose for themselves as offering the most good and by this criterion should all therapies of ulcer be judged.

A natural query would be as to what might be one's own personal approach to the ulcer problem. It would be as follows: "Exhaust every method and avenue of non-operative approach and, if operation

is inevitable, avoid the procedure of unknown consequences."

I am reminded again of the discussor at Atlantic City, who advocated adherence to the Ten Commandments as obviating the need for resections and vagotomies.

Long centuries before Christ, there existed an old Chinese philosopher, Lao Tze, who in philosophizing, incidentally as a side line, founded a religion. It seems these old philosophers were much taken up with a contemplation and scrutiny of the navel. Quiet, uninterrupted contemplation of this area stimulated profound thoughts and Lao came up with this one. Man was unhappy because all his life he did things which were distasteful and in reality unnecessary. Man should apply himself diligently to doing only that which he would like to do.

Inasmuch as we started this paper with the southern gastro-enterologist's offering of Teaxs bear grease, we can close with the very latest "hot off the griddle" pronounciamientos. If you have an ulcer, do not look any further; the reason you

have an ulcer is because you are mental. You either fought with your mother when you were a youngster, or your father for that matter. You did not mature, that is psychoanalytically speaking, and you did not have the amount of parental affection you should have had bestowed on you.

To those who are smugly smiling because they have no ulcers, beware, for all you know you may be handing an ulcer to your son or your grandson, particularly if your life at home is peppery and irritable. Do not argue with your wife about that new fur coat. If Johnny is around he will get an ulcer sure. Give your wife that coat; it may be cheaper in the end.

If you have children, be careful, very careful. Do not love them too much; do not speak cross to them; do not beat them and do not try pushing them around. If you do not get an ulcer, they will; and if they do not, their children will, and those are your grandchildren. They will run around pushing a finger of scorn at you saying, "That's my grand-daddy and he gave me ulcers."



# NEW PREGNANCY TEST

## USE OF THREE INJECTIONS OF ESTRONE IN OIL\*

SHERMAN S. GARRETT, M.D.

*Champaign, Illinois*

MUCH effort has been expended in attempting to devise an acceptable test for early pregnancy. The many technics that have been suggested for such a test bear witness that none so far have proved entirely satisfactory.

Without attempting to make a complete listing, several of the most interesting pregnancy tests may be mentioned. Among the best known are those involving injection of blood or urine from the patient into a laboratory animal, such as a rat or mouse (Aschheim-Zondek)<sup>1</sup> or rabbit (Friedman).<sup>2</sup> In interpretation of this test certain vascular and other changes in the reproductive system found at autopsy are interpreted as being positive for pregnancy. Frogs and toads are also used and the appearance of ovulation (Weisman and Coates)<sup>3</sup> or of spermatozoa in the urine (Galli-Mainini)<sup>4</sup> is presumed to indicate a positive test.

These technics require that a blood or urine specimen from the patient be sent to a laboratory equipped to handle live animals. Here the cost of the animals, their care and the salary of a well trained technician to interpret the results make these pregnancy tests rather expensive. Also, during the war it was the author's experience that the accuracy of the tests as performed by commercial laboratories deteriorated to such a low point that they were of little clinical value.

In another type of pregnancy test the patient is given injections of neostigmine methylsulfate, one each day for three days.<sup>5</sup> Appearance of menstruation is said to demonstrate the absence of

pregnancy. Although this test has some enthusiastic users, Winkelstein<sup>6</sup> points out that there is danger of producing abortion with use of this drug. The chance that this will occur is probably slight.

Gediz<sup>7</sup> has suggested an interesting pregnancy test using corpus luteum. According to this author, a patient with overdue menstruation, given proluton 10 mg. each day for five doses, will menstruate within five to seven days if she is not pregnant. The worst drawback to this test, as the author points out, is the cost of the drug. I have had no experience with the Gediz test, which was called to my attention by Hartman,<sup>8</sup> and so far I have not seen it mentioned in any American publication.

The new pregnancy test that I have devised was suggested by results obtained in treatment of amenorrhea with estrone, begun when this drug was first introduced. The test has been used with slightly varying technic on some 250 patients without a single incorrect result. It consists of an intramuscular injection of three doses of estrone in oil, 1 mg. each, over a period of five days in certain selected patients. Failure to menstruate within twenty-four hours after the last injection is interpreted as a positive test for pregnancy.

This test is inexpensive and simple to perform in the office without the aid of an outside laboratory. Equally important is that in the eyes of the patient the answer which she herself brings is more impressive to her than the typed line on a card from a distant laboratory. The result is sometimes obtained within a few hours,

\* The estrone in oil which was used in this study, 1.0 mg. per cc., was furnished by Eli Lilly & Company.

always within six days unless the physician, to suit his convenience, extends it to seven days.

That the test has proved completely accurate in the author's hands is probably due to accidental good fortune. Many failures will undoubtedly occur although the percentage of accuracy should be high.

*Subjects Suitable for Test.* To be a suitable subject for this test the patient should fulfill the following conditions: (1) She must have a history of reasonably regular menstrual periods. (2) Her menstrual period must be overdue. (There must be no vaginal bleeding.) (3) She must be of fairly healthy appearance with no marked anemia to be noted on inspection of the tongue. (4) She must present reasonably normal findings at pelvic examination although she may have signs suggesting pregnancy. (5) She must not have had any recent endocrine treatment. (Thyroid is a possible exception.)

It is found that practically all patients requesting an early diagnosis as to pregnancy will satisfy the aforementioned requirements. Only one young woman who requested diagnosis during the period covered by the fifty cases presented herein was considered unsuitable for the test (she was anemic) if one excepts patients who were bleeding.

There is a temptation to try the test on the patient whose menses have been overdue for some days or weeks and who comes to a physician with a slight bloody discharge. This should not be done with any hope of success.

#### TECHNIC

On the patient's first visit to the office a history is taken and a physical examination, including pelvic examination, is made. If she satisfies the five conditions previously stated, she is considered suitable for the test which is administered as follows:

1. One mg. estrone in oil is injected deep into a deltoid muscle.

2. Either forty-eight or seventy-two (approximately) hours later a similar injection is made into the other deltoid.

3. Approximately 120 hours (five days) after the first injection, an injection of 1 mg. estrone in oil is administered into the deltoid which was first used.

*Alternate Method.* If calculations show that the third injection cannot be made five days after the first injection, (for instance if this day falls on a Sunday) the second injection is made seventy-two hours after the first and the third injection is made six days after the first.

It will be noted that if the physician keeps office hours every day except Sunday the test may be started on any day of the week. Of course, if menstruation intervenes at any time, a diagnosis of not pregnant is made and the test is discontinued.

*Interpretation of Test.* If a vaginal flow of blood begins within twenty-four hours after the third estrone injection and lasts twenty-four hours or more, the patient is presumed to be not pregnant. If the patient fails to have such a vaginal flow, she is presumed to be pregnant.

In my experience there has been no difficulty in making this interpretation. The patient either has what appears to be a fairly normal menstrual period or she does not flow at all.

#### PRESENTATION OF PATIENTS

Table 1 shows the results in fifty patients receiving the test described herein. The first eighteen cases, although not consecutive, were selected only because complete data was available on them. The last thirty-two cases are consecutive cases of women who completed the test.

The table given here represents in a private obstetrical practice the average run of patients who come seeking a diagnosis as to pregnancy. As indicated the ages varied from fifteen to forty-six years, twenty-five and six tenths years being the average and twenty-three the median. The menses were overdue from three to

TABLE I

Case Nos.	Age	Pre-vious Preg-nancies	Days—Men-strual Period Over-due	Impres-sion from History and Pel-vic Ex-amina-tion Preg-nant?	No. of Injec-tions Given	Flow Began after First Injec-tion	Flow Began after Second Injec-tion	Flow Began after Third Injec-tion	Flow Began Hours after Start of Test	Diagno-sis from Test—Preg-nant?	Final Diagno-sis from Follow-up Preg-nant?
1	28	2	5	No	2	0	+	..	25½	No	No
2	28	1	5	No	1	0	+	..	61½	No	No
3	25	0	8	Yes	3	0	0	+	134	No	No
4	29	2	4	No	1	+	..	..	19	No	No
5	30	1	12	Yes	2	0	+	..	62	No	No
6	20	0	11	Yes	3	0	0	0	.....	Yes	Yes
7	15	0	32	Yes	3	0	0	0	.....	Yes	Yes
8	28	0	3	No	1	+	..	..	1½	No	No
9	20	0	12	Yes	3	0	0	0	.....	Yes	Yes
10	22	0	12	Yes	3	0	0	0	.....	Yes	Yes
11	20	0	3	Yes	3	0	0	0	.....	Yes	Yes
12	31	2	3	No	2	0	+	..	60½	No	No
13	22	0	15	Yes	3	0	0	0	.....	Yes	Yes
14	24	0	10	Yes	3	0	0	0	.....	Yes	Yes
15	23	0	5	Yes	3	0	0	0	.....	Yes	Yes
16	22	1	6	No	1	+	..	..	18	No	No
17	46	5	36	No	1	+	..	..	26	No	No
18	23	1	4	No	3	0	0	0	.....	Yes	Yes
19	20	0	12	Yes	3	0	0	0	.....	Yes	Yes
20	26	0	8	No	1	+	..	..	18	No	No
21	22	0	3	No	1	+	..	..	13	No	No
22	26	0	12	Yes	1	+	..	..	20½	No	No
23	19	0	4	Yes	3	0	0	0	.....	Yes	Yes
24	35	4	36	Yes	3	0	0	0	.....	Yes	Yes
25	37	2	5	No	3	0	0	+	122½	No	No
26	33	2	12	Yes	3	0	0	0	.....	Yes	Yes
27	24	0	8	Yes	1	+	..	..	20	No	No
28	20	0	4	No	3	0	0	0	.....	Yes	Yes
29	23	0	15	Yes	3	0	0	0	.....	Yes	Yes
30	23	0	14	No	2	0	+	..	113	No	No
31	38	3	4	No	1	+	..	..	30	No	No
32	17	0	33	Yes	3	0	0	0	.....	Yes	Yes
33	22	1	11	Yes	3	0	0	0	.....	Yes	Yes
34	22	1	6	No	1	+	..	..	37	No	No
35	30	1	9	Yes	3	0	0	0	.....	Yes	Yes
36	24	0	8	Yes	3	0	0	0	.....	Yes	Yes
37	27	8	20	Yes	3	0	0	0	.....	Yes	Yes
38	19	0	14	Yes	3	0	0	0	.....	Yes	Yes
39	20	0	20	Yes	3	0	0	0	.....	Yes	Yes
40	28	1	13	Yes	3	0	0	0	.....	Yes	Yes
41	31	0	29	Yes	3	0	0	0	.....	Yes	Yes
42	22	0	35	Yes	3	0	0	0	.....	Yes	Yes
43	29	0	6	No	1	+	..	..	.....	Yes	Yes
44	20	0	10	Yes	1	+	..	..	35	No	No
45	21	0	22	Yes	3	0	0	0	22	No	No
46	43	6	21	No	3	0	0	0	.....	Yes	Yes
47	23	0	28	Yes	3	0	0	0	.....	Yes	Yes
48	28	3	18	Yes	3	0	0	0	.....	Yes	Yes
49	29	0	20	Yes	3	0	0	0	.....	Yes	Yes
50	23	1	16	Yes	3	0	0	0	.....	Yes	Yes

thirty-six days, with an average of thirteen days and a median of eleven days.

There was in each case some reason for performing the test. In some the time overdue was so short that an accurate diagnosis from pelvic examination alone was un-

TABLE II

Controls—pregnant women				
Control no.....	1	4	5	7
Age of patient.....	20	21	34	27
No. previous pregnancies.....	0	1	2	1
Days overdue.....	21	19	4	7
No. control injections.....	2	2	2	2
No. estrone injections.....	3	3	3	3
Diagnosis correct?.....	Yes	Yes	Yes	Yes

likely. Several patients were too obese for a satisfactory pelvic examination to be made. Others denied the possibility of pregnancy or insisted on some further assurance that the clinical diagnosis was correct. One patient was so near the menopause age that confirmation was desired.

In each case an attempt at diagnosis was made from pelvic examination at the first visit. This impression was correct in forty-two patients of fifty, with a percentage of eighty-four per cent on pelvic examination alone. An incorrect positive diagnosis was made five times and an incorrect negative diagnosis three times.

Of the fifty women tested nineteen were shown by the test not to be pregnant; thirty-one were correctly diagnosed as pregnant. Of the non-pregnant women thirteen (68 per cent) menstruated after the first injection of estrone; four (21 per cent) after the second. Two (10 per cent) required three injections. In the nineteen non-pregnant women the shortest time required for bleeding to start after the beginning of the test (first injection) was one and one-half hours. The longest time was 134 hours, the average being 44.

As shown in the table the test was accurate in all cases with an accuracy of

100 per cent. This was determined by careful follow-up. One patient who was pregnant had a spontaneous abortion. Two admitted to having resorted to induced abortion. The others who were shown by the test to be pregnant have either been

TABLE III

Controls—non-pregnant women			
Control no.....	2	3	6
Age of patient.....	18	29	21
No. previous pregnancies.....	0	1	0
Days overdue.....	16	7	3
No. control injections.....	2	2	2
No. estrone injections.....	1	1	2
Flow—hours after last injection....	14	40	11
Diagnosis correct?.....	Yes	Yes	Yes

delivered or are well on their way to term. All those in the non pregnant group have continued with normal menses, or at least there is nothing sufficiently abnormal to call for medical attention.

**Control Series.** To provide a thoroughly accurate control series it would be necessary to administer three blank (inactive) injections followed by three injections of estrone over a period of two weeks. To obtain such controls involves difficulties in an office practice as few women will submit to this treatment when a pelvic examination will provide the same answer in about the same time. Since 90 per cent of non-pregnant women were found to menstruate after only two estrone injections, it was thought that administration of two blank injections followed by the test as described would provide a satisfactory control. Ampules of pure cotton seed oil were used for the control cases.

The control test was given to eight patients. Four of them failed to menstruate and were found to be pregnant. (Table II.) Three non-pregnant women were given the control test with results shown in Table III. The eighth patient, after two injections of cotton seed oil and two of estrone, discontinued the test and

apparently, from the information available, submitted to an induced abortion.

Since the statement of this pregnancy test limits its use to women who have a history of regular menstrual periods, it would not be surprising if some of them would menstruate while receiving control injections for they would all, presumably, menstruate sooner or later. It happened that none of the controls did this, but if some had done so it would not have invalidated the test. I believe that the fact that eight of the nineteen non-pregnant women in the non-control series were a week or more overdue when tested is even more significant than any control series could be. After the tables given here were completed a non-pregnant woman, aged nineteen who was twenty-eight days overdue, was given the test. She menstruated fifty-three hours after one estrone injection.

Stilbestrol by mouth was tried as a pregnancy test on one patient without success. When overdue three days, she was given the test as described herein, with oral administration of diethylstilbestrol, 5 mg. enteric coated, substituted for each estrone injection. Although the patient was not pregnant, she did not menstruate until five days after the third pill was taken. This patient, who was under sterility treatment, conceived twelve days after the beginning of this menstruation.

#### COMMENTS

In all of the various 250 patients whom I have tested for pregnancy there has been no difficulty whatever in interpreting the findings. All of the non-pregnant women had what appeared to be for them a fairly normal menstrual period. In a few of these women the rate of flow was reported as slightly increased, usually with some shortening of the duration of flow.

Practically all of the non-pregnant group were carefully questioned as to the passage of clots or tissue. If a woman was in the

habit of passing small clots during menstruation, she usually did the same following administration of the test. One patient stated that this was more noticeable. No one ever stated that she passed large clots or anything resembling tissue.

It was thought that administration of estrogenic substance would produce abortion in humans, but this idea has been disproved by Vaux and Rakoff<sup>9</sup> and by Karnaky.<sup>10</sup> It is possible that it may do so in animals, including monkeys, (Hartman)<sup>8</sup> but in humans, on the contrary, estrogenic substances are now used in the treatment of threatened abortion and habitual abortion.

Those in the pregnant group, as shown by this test, reported no bleeding whatever. The only exception to this was one patient who told of noticing a spot of blood on her clothing the size of a five cent piece nineteen hours after the second injection. This was ignored in interpreting the test and the third estrone injection was given with no further bleeding noted.

In the light of the several suggestions for use of estrogenic substances for the prevention of abortion it is interesting to note that of the many patients who have received this test only one has had a spontaneous abortion. This patient reported spotting before submitting to the test. The accident occurred some weeks after the test was given.

None of the patients reported here were receiving any endocrine treatment at the time of the test, except for two who were receiving desiccated thyroid by mouth as part of the treatment for sterility. Both were correctly diagnosed by the test as pregnant. (Case Nos. 26 and 49.) Additional data will be required before one can know whether or not endocrine preparations interfere with the test.

#### THEORY OF TEST

In effect, the statement of this test for pregnancy says that the intramuscular injection of 3 mg. of estrone in divided doses in a pregnant women will not pro-



ducc vaginal bleeding. This fact is sufficiently well established to need no further comment.

The statement further says, in essence, that any healthy woman with a history of regular menstruation who presents nothing abnormal on pelvic examination other than possible signs of pregnancy and whose menses are overdue will, if given 3 mg. of estrone in divided doses, have vaginal bleeding.

It is possible that menstruation occurring in non-pregnant women receiving the test is in a few cases coincidental; that is, it would have happened without treatment. However, it is unlikely that this occurs in many cases since 68 per cent of the non-pregnant women menstruated after the first estrone injection while only 10 per cent menstruated after the third dose and *all menstruated within twenty-four hours after the last injection*.

While the author has assumed that the vaginal bleeding in the non-pregnant patients reported here was true menstruation, there is no proof that it was such. However, the patients said that the bleeding appeared to be normal menstruation and later periods were reported as normal and approximately on time although not all were asked about the second menstruation. It is, of course, a common mistake for women expecting menstruation to assume that any vaginal bleeding is menstruation if it is not in abnormal amount.

Since we do not know the cause of *normal menstruation* in women,<sup>11</sup> any explanation of the mechanism responsible for the working of this pregnancy test can be only a surmise.

Although monkeys do not complain of overdue menstruation, certain animal experiments seem to bear out a plausible explanation for this test. The following conclusions were reached by Corner<sup>11</sup> as part of the results of his careful and brilliant studies on monkeys. Some of these findings were original while the others were confirmed by him:<sup>11</sup> (1) Estrone deprivation causes uterine bleed-

ing. (2) The estrone-deprivation hypothesis in its simple original form is not adequate to explain the observed facts of menstruation. (3) Progesterone prevents estrone-deprivation bleeding and also prevents menstruation. (4) Progesterone deprivation, like estrone deprivation, causes menstruation-like bleeding. (5) *Estrone does not prevent menstruation*.

Corner tells of an interesting experiment,<sup>11</sup> carried out many times, that illustrates the last two of these points which are especially important here. A castrated female monkey was given a daily dose of estrone to build up the endometrium to a normal structure. After ten days of this a daily dose of progesterone was added so as to simulate the normal menstrual cycle. If the progesterone was stopped when ten doses had been given (twentieth day) while the estrone was continued, the monkey would invariably bleed after a few days in spite of the estrone.

The following theoretical explanation for the pregnancy test I have devised is based on the results of monkey experiments as just given: If we reason that delayed menstruation is due to progesterone secretion that persists because of incomplete degeneration of the corpus luteum, then the antagonistic action<sup>8,11</sup> of estrone against progesterone eliminates the last effect of the declining progesterone action and allows menstruation to begin.

There is no proof that I know of that delayed menstruation is due to persistence of the corpus luteum although from the results of animal experiments it is a likely explanation. Corner's theory of menstruation is based on the cyclic variation of progesterone.<sup>11</sup> However, merely because a certain endocrine action is noted in animals it does not mean that this action will be the same in women. The mistaken idea, adhered to for a number of years, that estrogens will produce abortion in women when the exact opposite appears to be true is an example of the harm that can be done when we are too insistent on carrying over ideas based on

animal experiments. There is no good reason for our always insisting upon animal experiments to back up our clinical experience when we have before us results of the action of drugs upon women which we can, with little effort, observe and record.

Another possible factor in this test is the hyperemia of the uterus (and other organs) produced by administration of estrogens.<sup>12</sup> Production of uterine hyperemia is offered as an explanation of the neostigmine methylsulfate pregnancy test.<sup>5</sup>

#### LIMITATIONS OF TEST

The pregnancy test herein described is applicable to the vast majority of those seeking a diagnosis as to pregnancy. The usual patient who comes for such a purpose is more apt to have a gleam in her eye and a bloom on her cheek than the tint of chlorosis; she is healthy and not anemic.

The greatest shortcoming of this test is that it is not applicable to a patient who is bleeding. The woman, whose vaginal flow is overdue for a period of days or weeks and then appears, is a constant worry to the physician. He must rely on a shrewd guess as to whether she is pregnant and act accordingly, or he must subject her to the possible danger of infection from a pelvic examination in order to make a diagnosis. This test is of no help in these frequently encountered cases. Although I have not attempted the test in a patient with ectopic pregnancy, it will probably prove to be of little value in this instance. The same holds true for mole and chorionepithelioma, but since such cases are comparatively rare, percentage-wise, the test will prove satisfactory for routine use on most patients who walk into the physician's office.

As the test has been used on only four women approaching the menopause age, one reported here, caution should be used in the interpretation of results in such patients until more data is available.

#### SUMMARY

Of the many suggested tests for pregnancy none is entirely satisfactory.

A new pregnancy test, apparently highly accurate, is presented. It is inexpensive and simple to perform in the office without the use of animals or the aid of an outside laboratory.

In suitably selected patients, and nearly all can qualify, three injections of estrone in oil, 1 mg. each, are given over a period of five days.

If the patient fails to have vaginal bleeding within twenty-four hours after the third dose of estrone, she may be presumed to be pregnant.

The test has been 100 per cent accurate in over 250 cases. Fifty cases are presented, with controls.

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# MANAGEMENT OF ANOXIA DURING PENTOTHAL ANESTHESIA\*

B. ETSTEN, M.D.  
*Albany, New York*

AND

H. E. HIMWICH, M.D.\*  
*Edgewood Arsenal, Maryland*

**I**NTRAVENOUS administration of pentothal sodium for the production of surgical anesthesia has received increased use since the first clinical trial fourteen years ago. Various clinical investigators have attested its value for short surgical procedures, control of convulsions, major abdominal intervention and induction previous to inhalation agents.<sup>1-4</sup> It is well recognized that this drug has a special depressant action upon the respiratory centers causing retardation in respiratory exchange, diminution in tidal volume and even respiratory arrest.<sup>5,6</sup> These depressant effects usually result in direct proportion to the concentration and especially the rate of injection of the drug. Respiratory depression occurring in the upper levels of anesthesia is usually temporary but in the later stages becomes prolonged because the respiratory centers are then deprived of their metabolic support.<sup>7</sup> The phenomenon of sudden respiratory arrest in light anesthesia may be avoided by the slow, intravenous administration of pentothal and when this precaution is observed progressive diminution of breathing becomes consistent with the metabolic inhibition of the brain.<sup>8</sup>

The methods of administration of this drug and the attempts to avoid anoxia are varied. Some anesthetists allow the patient to breathe only air; others administer oxygen either by nasal catheter, by BLB mask or anesthetic machine.<sup>9-13</sup> These variations in the management of anoxia reveal a lack of knowledge concerning the effects of pentothal anesthesia upon the arterial oxygenation and the level of carbon dioxide in the blood stream during the various stages of anesthesia.

A recent investigation by Etsten and

Himwich<sup>7</sup> has demonstrated that the signs and stages of pentothal anesthesia may be correlated with an underlying physiologic mechanism. These investigators<sup>1</sup> have shown that the course of pentothal anesthesia can be divided into four stages. stage I, analgesia; stage II, hypersensitivity; stage III, surgical anesthesia: plane 1, light; plane 2, moderate; plane 3, deep; stage IV, impending failure.

They have also observed that during the first and second stages the retardation of cerebral metabolism occurs predominantly in the cortex and that a metabolic depression of the entire brain up to the medulla occurs during deep anesthesia. In addition to the metabolic effect there is another, inhibition of the activity of certain cerebral areas including the respiratory centers. This two-fold action of pentothal explains the variations in the degree of arterial oxygenation during anesthesia. Some of the signs of anoxia, such as cyanosis, tachycardia or bradycardia, tachypnea and hypertension may be masked or missed during the clinical course of pentothal anesthesia, particularly in the surgical stage. The irreversible damage to the brain caused by severe anoxia is only too often discovered in the postoperative period. The purpose of this paper is, therefore, to determine the degree of oxygenation of the blood during pentothal anesthesia, determinations which are to serve as a guideline to the limits of safety.

## METHOD

A 1 per cent solution of pentothal sodium was administered intravenously to non-premedicated and non-operative subjects. The solution was controlled either by an intravenous drip or syringe connected in

\* From the Departments of Anesthesiology and Physiology and Pharmacology, Albany Hospital and Albany Medical College, Union University, Albany, N. Y.

series with a two-way stopcock and needle inserted into the antebrachial vein. The patient was anesthetized slowly so as to avoid any undue respiratory depression.

Arterial blood samples were drawn from the femoral artery while the patient was in the resting state and during the various stages and planes of anesthesia. The blood samples were kept under glass and over mercury in order to avoid any contaminating exchange of gases with air. The samples were analyzed for oxygen content, oxygen capacity and carbon dioxide content by the method of VanSlyke and Neill.<sup>14</sup>

### RESULTS

Thirty-eight observations were made on eleven patients. The data obtained (Table 1) indicate that respiratory activity is adequate in stage I, stage II and plane 1 of stage III. In the second and third planes of stage III respirations are depressed as shown by marked arterial oxygen saturation and carbon dioxide retention.

The arterial oxygen saturation of the subjects in the resting state ranged from 92 to 96 per cent and the anesthetized subjects in stages I and II had similar percentages of saturation as shown in the accompanying illustration. In plane 1 of stage III the saturation varied from 87 to 86 per cent, values still within the comparatively safe zone of oxygenation. In plane 2 of stage III arterial oxygen saturation ranges from 77 to 82 per cent with an average of 82 per cent. In plane 3 of stage III the anoxia becomes even more marked with an arterial oxygen saturation average of 40 per cent and usually a definite increase in arterial carbon dioxide content.

The arterial carbon dioxide contents during the various stages of anesthesia are found in Table II. Each patient served as his own control and the variations are demonstrated as the patient was subjected to different stages of anesthesia.

### COMMENT

The most frequent result of pentothal anesthesia was a retention of carbon dioxide in the blood stream which became

marked in the deeper stages of anesthesia. Nevertheless, this retention was not observed in all instances. The accumulation of carbon dioxide in the blood can be accounted for by diminution of the respiratory exchange. This diminution is caused

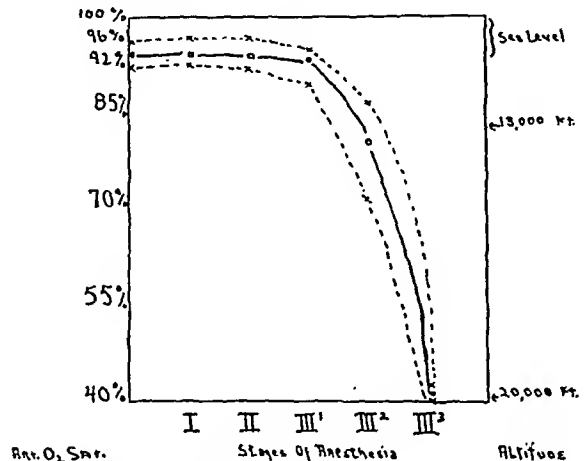


FIG. 1. The arterial oxygen saturation as determined in the various stages and planes of pentothal anesthesia is compared to the arterial saturation of a non-anesthetized person breathing air at different altitudes.

by the depressant action of pentothal upon the respiratory centers plus the partial withdrawal of their metabolic support. This retention of carbon dioxide indicates that the sensitivity of the respiratory center to its normal physiologic stimulus is diminished. Moderate increases of carbon dioxide in the blood stream may enhance muscle tonus or sharpen sensitivity to a painful stimulus, perhaps by inhibiting the cholinesterase.<sup>15</sup> This rise of carbon dioxide may be one of the reasons for the muscular response to pain which may occur in the deeper stages of narcosis. Such hypersensitivity will mask the depth of anesthesia and when more drug is given to overcome this muscular reaction an excessive degree of central depression develops after the painful surgical stimulus is withdrawn.

The progressive reduction in arterial oxygen saturation during pentothal anesthesia is marked in the stage of moderate surgical anesthesia and severe in the stage of deep surgical anesthesia. Here, as with carbon dioxide, the clinical state of anoxia and degree of depression of the respiratory center may be masked in the stage of

TABLE I\*  
ARTERIAL OXYGEN CONTENT AND CAPACITY DURING  
PENTOTHAL ANESTHESIA

No.	Stage	Arterial O <sub>2</sub> Content	Arterial O <sub>2</sub> Capacity	Arterial O <sub>2</sub> % Satur- ation
1	Control Stage III, plane 3	15.65	16.32	95
		14.21	16.32	87
2	Control Stage III, plane 3	16.73	17.57	95
		15.85	17.57	91
3	Control	18.22	19.65	94
	Stage II	17.86	19.45	92
	Stage III, plane 1	17.17	19.45	88
	Stage III, plane 2	15.46	18.81	82
	Stage III, plane 3	15.89	20.81	84
4	Control	19.65	20.84	94
	Stage II	18.12	18.88	96
	Stage III, plane 1	17.47	18.59	94
	Stage III, plane 2	16.33	18.59	88
	Stage III, plane 3	7.27	18.88	38
5	Stage II	16.82	18.48	91
	Stage III, plane 2	14.98	18.48	81
6	Control	19.78	20.82	95
	Stage I	17.08	17.90	95
	Stage III, plane 1	16.86	18.49	91
	Stage III, plane 2	15.97	17.90	89
	Stage III, plane 3	15.28	18.49	83
7	Control	19.24	20.25	95
	Stage III, plane 1	17.98	19.72	91
	Stage III, plane 2	15.56	19.72	80
8	Control	18.29	19.11	96
	Stage II	18.83	19.61	96
	Stage III, plane 1	18.80	19.61	96
9	Control	20.47	22.14	92
	Stage I	19.65	22.14	93
	Stage II	19.23	21.14	91
	Stage III, plane 1	18.50	21.29	87
	Stage III, plane 2	8.88	21.29	42
10	Control	18.05	18.50	97
	Stage II	17.73	17.81	99.5
	Stage III, plane 2	13.01	17.81	73
11	Control	17.33	18.59	93
	Stage II	15.59	15.92	98
	Stage III, plane 1	15.29	15.92	96
	Stage III, plane 1	15.72	16.59	95
	Stage III, plane 2	13.45	15.92	84
	Stage III, plane 3	6.37	16.59	38

\*The oxygen content and capacity of the arterial blood was analyzed in eleven patients. Each patient was subjected to different stages of pentothal anesthesia. Analyses checked to 0.2 volumes per cent.

moderate surgical anesthesia. This masking can be attributed to: (1) Stimulation of the carotid bodies in response to the arterial desaturation; (2) the periodic stimulation of the respiratory center by painful stimuli evoked during surgery and (3) the periph-

TABLE II\*  
ARTERIAL CO<sub>2</sub> CONTENT DURING PENTOTHAL ANESTHESIA

No.	Stage	CO <sub>2</sub> Content
1	Control Stage III, plane 3	52.47
		56.43
2	Control Stage III, plane 1	52.97
		58.47
3	Control Stage III, plane 2	51.20
		54.0
4	Control Stage III, plane 3	50.40
		61.61
5	Control Stage II	53.32
		46.94
6	Control Stage II	54.26
		50.39
7	Control Stage I	52.66
		50.53
8	Control Stage III, plane 2	53.32
		56.07
9	Control Stage III, plane 1	51.20
		50.61

\* The carbon dioxide content of the arterial blood is determined in the resting state and in a definite stage and plane of pentothal anesthesia. Each patient serves as his own control.

eral vasodilatation produced by the increased carbon dioxide in the blood stream. It is in this stage of moderate surgical anesthesia that the administration of oxygen is imperative. The method of administration is not so important at this time as long as the atmosphere that the patient inspires is adequately enriched with oxygen to fully saturate the arterial blood.

In the stage of deep surgical anesthesia the arterial oxygen saturation falls to dangerously low levels as was previously stressed. The respiratory center is depressed to such an extent that both the

accumulated carbon dioxide and the anoxic stimulus via the carotid body mechanism can no longer evoke respiratory stimulation.

Administration of oxygen by insufflation either by nasal catheter, by BLB mask or anesthetic mask and bag increases the oxygen saturation of the blood and alleviates the anoxia but, nevertheless, the carbon dioxide will steadily increase. When the anoxic stimulus to the carotid body during pentothal anesthesia is removed by administration of oxygen, breathing becomes more shallow. The carbon dioxide content of the arterial blood is increased because the maintenance of a normal level of this gas is dependent upon active and adequate respiratory excursions.<sup>16</sup> When breathing is greatly depressed, the tidal exchange of physiologic gases, including the carbon dioxide in the alveoli, will increase.<sup>17</sup> Therefore, it is necessary to enhance the inspiratory effort and, in turn, augment the exchange of gases. In this stage of pentothal anesthesia it is important not only to administer oxygen by anesthetic face mask and bag but also to supplement respirations by manually compressing the breathing bag during each inspiratory effort. The aforementioned method is intended to simulate normal respirations so that the concentration of carbon dioxide does not accumulate either in the alveolar spaces or blood stream. This is not intended to lower the carbon dioxide but to keep it within normal limits. The technic as outlined will not only remove the excess carbon dioxide but also will improve oxygenation.

#### SUMMARY

Experimental evidence is presented demonstrating that the intravenous administration of sodium pentothal produces anoxia and an increase of carbon dioxide content in the blood during moderate surgical anesthesia and deep surgical planes of anesthesia.

The institution of oxygen therapy by insufflation is insufficient to correct the

depletion or accumulation of the blood gases during the deep planes of anesthesia. Supplemental respiration technic of oxygen therapy is the most efficient method that can be instituted during pentothal anesthesia to avoid anoxia and hypercapnea.

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## THE TALCUM POWDER EVIL\*

M. G. SEELIG, M.D.

Atherton, California

THE talcum powder chapter is a long one, dating back more than sixty years. It was not, however, until 1942 that any extensive work was done with the aim of developing a substitute to use in place of talc. By that time the complications reported in the literature as caused by talc became so numerous that workers in the Barnard Free Skin and Cancer Hospital, St. Louis, Mo., spent the better part of five years systematically studying the effects of some thirty-five different powders on laboratory animals. These experiments led to the conclusion that potassium bitartrate made a desirable substitute for talcum. However, as time passed it developed that unless gloves powdered with potassium bitartrate were sterilized with meticulous care the powder tended to caramelize. We also thought at that time that potassium bitartrate shortened the life of rubber gloves. On this latter point we were probably in error because the Wilson Rubber Company, on their own initiative, instituted a series of careful experiments which showed that potassium bitartrate neither shortened the life of the gloves nor lessened the tensile strength of the rubber. (From a personal communication to the author.) Despite this we received so many personal reports concerning the difficulties encountered with sterilization that we decided to reopen the problem in order to continue our search for a more suitable powder. It is interesting to note that at about this time the Mayo Clinic substituted potassium bitartrate for talcum and reported later that they had been using it for two years.

Our later studies developed the fact that corn starch would serve as an ideal powder were it not for the fact that it gelatinized when subjected to steam auto-

claving. Thanks to the Corn Products Refining Company we learned that by subjecting starch to formaldehyde or to other aldehydes it could be robbed of its gelatinizing properties. But here again we ran into difficulty in that one must remove very completely all traces of the aldehyde radical in order to avoid an irritating dermatitis of the hands of some surgeons. Another difficulty was that the sterilized starch powder did not have complete freeness of flow. This problem of free flow, however, I do not regard as of too great importance. I believe that the best operating room technic calls for use of the powder in the form of sachets rather than from shaker cans. When sachets are used, the question of free flow loses much of its significance.

In the March, 1948 issue of *The American Journal of Surgery*—there appeared an article by workers of the Johnson & Johnson Laboratories, of New Brunswick, N. J. This report is a bit confusing because although they seem to recommend a modified starch, they do not say how it is modified nor do they call it starch. They refer to it as "a mixture of amylose and amylopectin derived from corn starch." I had always been of the opinion that corn starch was a mixture of amylose and amylopectin and starch chemists assure me that such is the fact. In a specimen of their powder that the Johnson & Johnson workers very kindly sent me I found evidence of the presence of aldehyde of some sort upon testing with Schiff's reagent. Chemists who repeated the test for me also reported the presence of aldehydes.

Another statement in the report of the Johnson & Johnson workers that causes me genuine concern is that their powder

\* From the Department of Pathology, The Barnard Free Skin and Cancer Hospital, St. Louis, Mo.

contains 1 per cent magnesium oxide in order to furnish a freer flow to the powder. In the work that I already referred to which was done at the Barnard Free Skin and Cancer Hospital magnesium oxide was one of the many powders that were tried. It was found to cause granuloma and plaque formation and was therefore discarded. We did think that it was somewhat better taken care of than was talcum, but it took a varying period of time before it was disposed of. During that time interval it could cause a great deal of harm. The situation is much like that which pertains to calcium carbonate. In their studies of noxious dusts workers in the United States Bureau of Mines reported that the only innocuous dust they found was calcium carbonate, in that although it did set up a reactionary inflammation in the tissues it was finally disposed of.

There is no doubt about the correctness of the observation of the Johnson & Johnson workers that magnesium oxide will increase the flow of starch. The manufacturers of table salt have known for a long while that by adding a little magnesium oxide they could prevent clumping

and furnish freer flow to the salt. The fact that it will increase the flow of starch, however, does not warrant the use of magnesium oxide in a surgical dusting powder. This statement is valid, I believe, even if it is present in a 1 per cent dilution. I am strongly inclined to believe that the presence of insoluble dusting powders in the tissues and particularly in the peritoneal cavity may cause damage totally out of proportion to the quantity of the material. In some instances a very small amount of an offending powder may set up an almost incredibly progressive chronic type of fibrosis. I have come to the conclusion, therefore, that when we are contemplating the harmfulness of non-absorbable surgical dusting powders, there is as little justification of talking or thinking in terms of "just a little bit" as there is of speaking of "a touch of pneumonia" or of a "little bit pregnant."

It is a hopeful sign that such an outstanding manufacturer as Johnson & Johnson has interested themselves in the surgical dusting powder problem, but that does not relieve surgeons of their duty to know just what they are using and how assuredly safe it is.





# SCALENUS ANTICUS SYNDROME TREATED BY SURGERY AND SKELETAL TRACTION

A. F. DE PALMA, M.D.

*Philadelphia, Pennsylvania*

THE writing of this article has been prompted for two reasons: First, because it has been the author's experience that very often the scalenus anticus syndrome is overshadowed by definite organic disorder in the cervical spine and hence not recognized; secondly, to present again before the profession a method of treatment, namely, skeletal traction to the cervical spine for those cases which have not responded to the ordinary conservative measures and in which surgical treatment is contraindicated or refused by the patient.

Since the publication by Adson and Coffey in 1927 on the surgical treatment of so-called "scalenus anticus syndrome," considerable knowledge has been added relative to the etiologic factors of the syndrome and its treatment. In spite of all this, it is surprisingly true that this syndrome is too often overlooked or unrecognized by physicians and surgeons and the patient's symptoms often assumed to be on a functional rather than on an organic basis. On the other hand, the syndrome having been recognized, the surgeon often fails to recognize the exciting factor which initiated the syndrome. This often leads to improper management of the patient and failure to alleviate the symptoms. Success in the treatment of this syndrome can be brought about only by first recognizing the entity and establishing the etiologic exciting factor responsible for the symptoms and secondly, by directing the treatment not only to the spastic or contracted scalenus anticus muscle but also to the responsible exciting factor when demonstrable.

*Symptoms.* The scalenus anticus syndrome is characterized by a distinct nervous and circulatory phenomenon in the affected extremity. The nervous phenomenon is

always present; the circulatory manifestations are rarely severe. The sensory symptoms are pain and paresthesia in the involved extremity. The pain is usually along the flexor and ulnar surfaces of the forearm, shoulder, angle of the scapula, pectoral muscles and often in the root of the neck and ear of the affected side. Later there may be muscular involvement; the thenar eminence may show definite atrophy (atrophy of the abductor pollicis muscle and opponens pollicis muscle) or there may be atrophy of the interossei muscles. These motor changes, however, are only rarely present.

The circulatory manifestations consist of decreased temperature, numbness and formication in the extremity. There is often a dusky hue and puffiness of the hand and forearm. Later definite trophic disturbance makes itself evident in the form of pallor, followed by cyanosis of the finger tips and eventually gangrene. Diminution of the radial pulse is a common finding. The radial pulse can be decreased, even obliterated by downward traction on the involved extremity, or by having the patient perform Adson's maneuver.\*

A great number of patients present only a few of the above findings, the most common symptoms being the sensory manifestations. This is especially true in the early stages of the syndrome. A very common finding, however, is tenderness in the supraclavicular fossa, especially over the distal one-third of the scalenus anticus muscle immediately lateral to the sternocleidomastoid muscle. Very often the scalenus anticus muscle is found on palpation to

\* In Adson's maneuver the radial pulse decreases in volume or becomes obliterated when the patient extends the cervical spine and rotates the head toward the affected extremity while taking a deep breath.

be tense, contracted and even hypertrophied. Pressure over this area elicits considerable tenderness and the pain is aggravated in the flexor surface of the arm.

*Etiology.* It is apparent from the foregoing symptoms that we have in this syndrome a disturbance of the normal physiology of the brachial plexus, of the subclavian artery and vessels of the affected extremity. It is generally accepted that the nervous manifestations are the result of irritation of the brachial plexus, especially of its middle and lower trunks. Irritation and stimulation of the plexus causes a spasm and contraction of the scalenus anticus muscle, which in turn causes an elevation of the first thoracic rib. The abnormal position of the first thoracic rib causes greater stimulation of the plexus whose branches supply the scaleni muscles; hence, a vicious cycle is established. Ochsner, Gage and De Bakey in 1935 set forth this explanation of the syndrome, without the presence of a cervical rib. This leaves much to speculation, however, as to what was the initial factor causing the stimulation of the plexus. When there is a demonstrable cervical rib or an abnormal cervical transverse process, one can assume that these factors are sufficient to initiate the syndrome. However, we know that many patients with cervical ribs do not have symptoms and as pointed out by Adson and Coffey in 1927 only thirty-six of 303 cases with cervical ribs had symptoms of sufficient severity to necessitate treatment. Fifty-five per cent of the 303 patients with cervical ribs had no symptoms. It becomes obvious, therefore, that even in the presence of a cervical rib and where no demonstrable pathological condition is present in the cervical spine, some other factor or factors come into play initiating the stimulation and irritation of the brachial plexus.

At this point it is appropriate to review the normal anatomy relative to the brachial plexus, subclavian artery and scalenus anticus muscle in the supraclavicular area. The scalenus anticus muscle arises from the transverse process of the third, fourth, fifth

and sixth cervical vertebrae. The muscle runs forward and downward to insert into the scaleni tubercle of the first rib. The cervicobrachial plexus runs laterally and behind the scalenus anticus muscle. Between the muscle and the first rib lie the brachial nerve trunks. The subclavian artery occupies a similar position. The scalenus anticus receives its nerve supply from the sixth cervical nerve root.

There is still considerable controversy relative to the abnormal physiology responsible for the vascular manifestations. Todd in 1912 expressed the belief that the symptoms were the result of stimulation of the sympathetic fibers in the lowest nerve trunk. Telford and Stafford in support of this view went still further and demonstrated in cadaver studies the presence of sympathetic fibers in the lowest brachial plexus trunk in the form of a distinct bundle whose position in the trunk readily predisposed it to pressure in the presence of a cervical rib. On the other hand, Gladstone and Wakely were of the belief that the symptoms in the syndrome are due to direct pressure on the plexus and subclavian artery. A review of the literature on this subject reveals, however, that most authorities are of the opinion that the nervous manifestations are the direct result of compression of the plexus causing irritation of the nerve fibers, while the vascular phenomenon is best explained on the premise that it is the result of irritation of the sympathetic fibers in the lowest trunk.

*Predisposing Factors.* There are several predisposing factors which may or may not be present. Certainly the presence of a cervical rib is to be considered as a predisposing agent in the presence of the syndrome. However, not all cases of cervical ribs give rise to symptoms. Adson explains this on the basis that only those patients have symptoms in which the scalenus anticus muscle inserts into the first rib by means of a broad fibrous tendon, hence the space between the scalenus anticus muscle and the cervical rib is greatly diminished. On the

other hand, symptoms are absent in those cases in which the muscle insertion is narrow and more mesial.

Congenital anomalies of the cervical vertebrae may also be predisposing factors. In such incidences the brachial plexus is often in an abnormal position relative to the surrounding structures.

Congenital anomalies of the scalenus anticus muscle itself may be present. In one case the lower two brachial trunks pierced the belly of the muscle.

Jones considered that the post-fixed plexus was more apt to develop the syndrome than the prefixed plexus. The component fibers of the lowest trunk of the post-fixed plexus arise from the upper thoracic segments of the spinal cord while the main portion of the prefixed plexus arises from the cervical segments of the spinal cord. In the former type of plexus, the nerve trunks are predisposed to irritation and stimulation because of their angulated position over the cervical or first thoracic rib.

*Exciting Factors.* There are many exciting factors which may initiate the syndrome. Todd pointed out that descent of the shoulder beyond normal limits in adulthood, especially in women, is a factor which may cause irritation and stimulation of the brachial plexus. Gladstone and Wakely were of the opinion that in the presence of cervical ribs the short ones produced compression of the brachial plexus while the long ones produced compression of the subclavian artery giving rise to the vascular symptoms. On the other hand, Adson believes that the scalenus anticus muscle was the principal agent in causing compression of the plexus. He further maintains that it is most likely to cause compression of the brachial plexus during the period of greatest activity and muscular development.

Posture must also be considered as an exciting factor. The syndrome is seen in many individuals with long necks and drooping shoulders. This abnormal droop of the shoulder girdles may very readily cause stretching, irritation and stimulation of the brachial plexus.

#### CASE REPORTS

**CASE I.** M. B. had a bilateral scalenus anticus syndrome. No disorder was found in the cervical spine or in either shoulder girdle. She was a tall, thin woman with a long neck and drooping shoulders. The syndrome had come on gradually, first in the left extremity and then in the right extremity about five months before seen by the author, March 15, 1940. She obtained immediate relief by strapping her shoulders to a T splint as used in clavicular fractures. The patient was then taught exercises to elevate and pull back the shoulder girdles. As long as the patient continued her exercises and maintained this position, she was free of pain. The patient remained free from pain until June 20, 1941, when she returned with the same set of symptoms. She had, however, neglected her exercises and had slumped into her former poor posture. This patient came to surgery and was relieved of all symptoms.

Another exciting agent is trauma, direct or indirect, to the brachial plexus or scalenus anticus muscle. Severe downward pressure on the shoulder has been the exciting factor in several patients whom the author has treated. This was also noted as the starting point of the syndrome in several marine recruits starting their training period. The symptoms came on after carrying heavy packs on their shoulders for long periods of time. In the following case the symptoms followed severe stretching of the upper extremity.

**CASE II.** M. V., a female, age thirty-two, was first seen on February 8, 1939, and gave the following history: While wringing out clothes, her left hand was caught in an electric wringer and in an attempt to pull out her hand she jumped backward and severely wrenched her left shoulder. On admission the left hand showed numerous contusions on the dorsal surface. There were no fractures. The patient complained of severe pain in the root of the neck, in the left shoulder and along the entire arm. The treatment outlined was rest of the arm in a sling and physiotherapy in the form of heat and massage to the entire extremity. Within two weeks there was complete recovery of the contused hand. Pain in the shoulder and arm, however, was more severe. Motion of the

cervical spine and of the shoulder joint was unrestricted. She complained of numbness and coldness in the entire forearm, more so along the flexor surface. The fourth and fifth fingers were, as the patient stated, "dead." The entire hand had a blotchy appearance. Pain was exaggerated upon performing Adson's maneuver. Pressure over the root of the neck on the left side exaggerated the pain. Some relief was obtained if the patient placed the left hand over her head. When last examined on September 3, 1941, the patient still complained of the same set of symptoms. During the period from the date of her injury to the date of this last examination the patient had been to numerous physicians, but all treatment failed to give any relief. She presented a typical scalenus anticus syndrome, undoubtedly due to stretching of the cervicobrachial plexus at the time of the injury. A division of the scalenus anticus muscle relieved all symptoms.

Occupations which tend to cause an abnormal droop of the shoulder or pull the shoulder girdle downward have been the exciting factor in several of the author's cases.

There is still another group of patients in whom this vicious syndrome is the result of stimulation of the cervicobrachial plexus or of the scalenus anticus muscle by demonstrable disturbance in the cervical spine. In these incidences treatment should primarily be directed toward relieving the spasm of the scalenus anticus muscle. It is in this group that the syndrome is often overlooked because it is overshadowed by the obvious organic disorder in the cervical spine.

CASE III. T. V., age twenty-six, was admitted on June 5, 1939, complaining of severe radiating pain in the left shoulder and arm. There was no history of trauma. The onset was gradual, starting with some stiffness in the neck three months before admission. Examination of the patient revealed a young adult male holding his head slightly forward and supporting the left elbow with his right hand. Motion in the cervical spine was restricted in all directions. There was severe muscle spasm of the posterior cervical group of muscles and of the trapezius and sternocleidomastoid muscle on

either side. Pressure over the root of the neck on the left side caused severe radiating pain down the left arm along the flexor surface of the forearm and into the fourth and fifth fingers. The skin of the left arm was hypersensitive and the dorsum of the hand was slightly swollen. The grip of the left hand was definitely diminished and the volume of the radial pulse was also diminished. X-ray examination revealed a tuberculous lesion affecting the fourth and fifth cervical vertebrae and a collapse of the intervening intervertebral disc. The patient was put to bed on June 21, 1939, and a spine fusion was done from the second cervical vertebrae to the seventh cervical vertebrae. The cervical spine was immobilized by a plaster jacket including the head and neck. Ten days following the operation he was completely free of shoulder and arm pain and made an excellent recovery. When last examined on September 21, 1941, he had solid fusion from C-2 to C-7 inclusive and was free of pain.

The scalenus anticus syndrome, in this instance, was either due to stimulation of the scalenus anticus muscle by the pathologic process present in the fourth and fifth cervical vertebrae or the pathologic process of the affected bodies caused direct irritation of the fourth and fifth cervical nerves and hence set off the same syndrome.

CASE IV. C. H., a male, age forty-three, was struck on July 14, 1938, on the back of the neck by a swinging chain suspended from a derrick. He was taken to the hospital where x-rays revealed a compression fracture and forward subluxation of the fourth cervical vertebra. The patient complained of more pain in the left shoulder and arm than of pain in the neck. The fracture and subluxation were reduced and a plaster jacket was applied holding the neck in a position of hyperextension. In spite of a perfect reduction the patient continued to complain of severe radiating pain into the left arm and into the fourth and fifth fingers. He also complained of numbness and coldness of the left hand. The dorsum of the hand was somewhat puffy and the grip of the hand was weakened. The volume of the left radial pulse was equal to that of the right radial pulse. The patient made an uneventful recovery. However, he always had some pain in the left

arm and hand which was characterized by periods of exacerbations.

When last examined on September 17, 1941, the patient still complained of radiating pain in the left shoulder, arm and hand. There was slight but definite atrophy of the muscles of the hyperthenar eminence. The hand had a

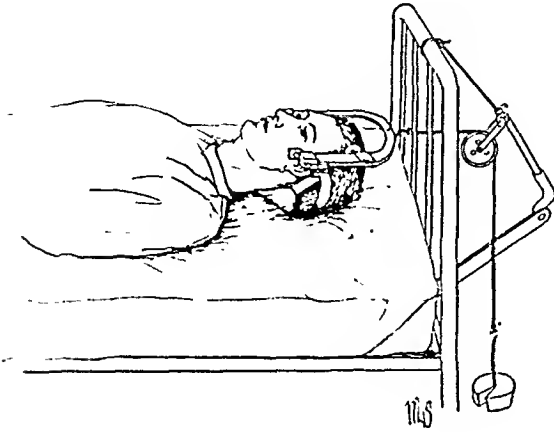


FIG. 1. Position of patient lying in traction.

glossy appearance. Pressure over the root of the neck on the left side exaggerated the pain. Traction downward on the left arm also exaggerated the pain. If the head was turned toward the affected side and extended, the pain was more intense. The radial pulse was equal to that of the unaffected side. A scalenus anticus syndrome in this case was undoubtedly initiated by trauma to the fourth cervical vertebra which in turn caused an irritation either of the scaleni muscles or cervicobrachial plexus. A division of the scalenus anticus relieved all the symptoms.

**CASE V.** In L. W. the syndrome was associated with advanced osteoarthritis of the cervical spine. The cervical spine was immobilized by a leather cervical collar for a period of six weeks. During this period intensive physiotherapy was administered in the form of heat and massage. The scalenus anticus syndrome began to disappear gradually as soon as the cervical spine was immobilized. In this case, however, the pain in the left shoulder and arm has never completely disappeared and there have been two periods of exacerbation of the syndrome. In each instance the syndrome was relieved by the application of the cervical collar.

The group of patients in which no gross pathological condition is demonstrable in the cervical spine or shoulder girdle present

a more difficult problem. Some of the patients, as previously stated, have a long neck and drooping shoulders. In these cases it may be assumed that the cervicobrachial plexus is being stretched by an abnormal descent of the shoulder girdle. Many of

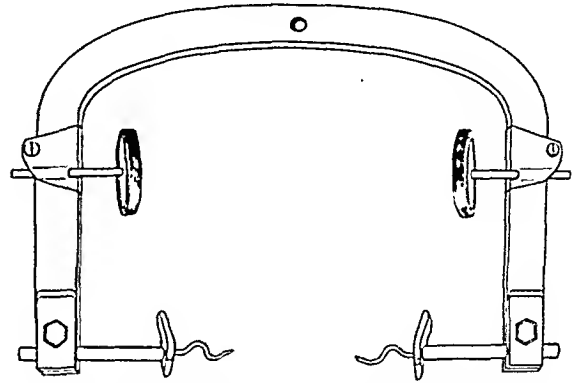


FIG. 2. Standard type of skeletal traction used.

these patients may be relieved and even cured by improving their posture.

**Treatment.** The milder forms of this syndrome in many instances will respond to conservative measures. Where there is evidence of poor posture characterized by drooping shoulders, corrective exercises and some type of support to pull the shoulder girdle up and backward will give considerable and prompt relief. If the syndrome has been initiated by the patient's occupation, a change of employment following a period of rest will suffice to bring about relief. When the syndrome is the result of direct or indirect trauma to the scalenus anticus muscle, rest to the part with the arm in an elevated position will give relief. These simple measures may at times have to be augmented by a sedative or by the injection of procaine into the scalenus anticus muscle. The procaine injection may have to be repeated several times before permanent relief of the symptoms is obtained.

When the conservative measures fail, one will have to resort either to traction on the cervical spine or to the division of the scalenus anticus muscle. I prefer surgical treatment to traction. However, there are many patients who refuse surgery or in whom surgery is contraindicated. In this group traction to the cervical spine is the treat-

ment of choice; and if properly applied and carried out, traction will invariably result in the relief of symptoms. I will admit that it is a more trying ordeal than surgery nevertheless in the selected cases it is warranted and justified. (Figs. 1 and 2.)

I prefer to use skeletal traction. Traction is obtained by means of steel hooks inserted beneath the zygomae. The steel hooks are inserted subperiosteally beneath the zygomae after the skin, underlying tissues and periosteum have been first infiltrated with procaine. Straight traction is made on the cervical spine by means of 5 to 10 pounds of weight. The patient lies on a flat, firm bed with no pillow under the head. The head rests on an even plane with the shoulders. If the hooks are properly applied, there is no pain or reaction at the sites of insertion of the hooks. Nursing care is facilitated because the patient is free to move about at will. The symptoms usually disappear within six to eight hours after traction has been applied. Traction is maintained for ten days after which the patient is made to wear a light cervical collar for two weeks. During this period heat and massage is given daily to the neck. To date seventeen patients have been treated by traction by the author. As yet only one has had recurrence of symptoms and this patient was relieved by surgery.

The following is an analysis of patients with scalenus anticus syndrome who were treated either by surgery or traction. There were eighteen males and thirty-two females. The age ranged from fifteen to fifty-eight years while the duration of the symptoms ranged from one day to thirty-four years. In five cases the syndrome came on immediately after direct trauma to the cervicobrachial plexus or scalenus anticus muscle. Twelve patients had associated organic pathological conditions of the cervical spine. Advanced osteoarthritis was found in eight; two had a tubercular lesion of the cervical spine and in two the symptoms followed fracture dislocation of the cervical spine. Cervical ribs were found in eight patients, two of whom had bilateral cervical ribs.

The nervous manifestations were the most prominent symptoms in all cases. Thirty-four had vascular manifestations of varying degrees; in nine of these, however, the circulatory findings were the prominent factors of the clinical picture. Six had no circulatory disturbances. Thirty-three patients were treated by surgery and seventeen by traction. In the first group twenty-six were completely relieved; seven patients still had some residual pain in the affected extremity but to a lesser degree than before operation. Of the seventeen patients treated by traction, all were relieved of pain except one who had a recurrence of symptoms. This patient was finally relieved by surgery.

#### SUMMARY

1. Scalenus anticus syndrome is a common entity and a cervical rib may or may not be present.

2. Most authorities believe that the nervous manifestations are the result of pressure on the lower trunks of the brachial plexus, while the vascular phenomenon is due to stimulation of the sympathetic fibers in the lowest trunk of the brachial plexus.

3. The syndrome may be initiated by stimulation of the cervicobrachial plexus which in turn causes contraction of the scalenus anticus muscle. As a result of this contraction the thoracic rib is elevated into an abnormal position compressing the nerve trunks and subclavian artery which lie between the scalenus anticus muscle and the first thoracic rib. A vicious cycle ensues.

4. It is possible that the syndrome may also be started by contraction of the scalenus anticus muscle due to direct trauma or irritation of the muscle. This may well explain the etiology of the syndrome in cases with a demonstrable organic disorder in the cervical vertebrae and in those patients who have a fracture dislocation of the cervical spine.

5. Treatment should be directed both to the etiologic factors and to the contracted scalenus anticus muscle. Symptoms will often disappear with adequate treatment of the demonstrable condition if present in the

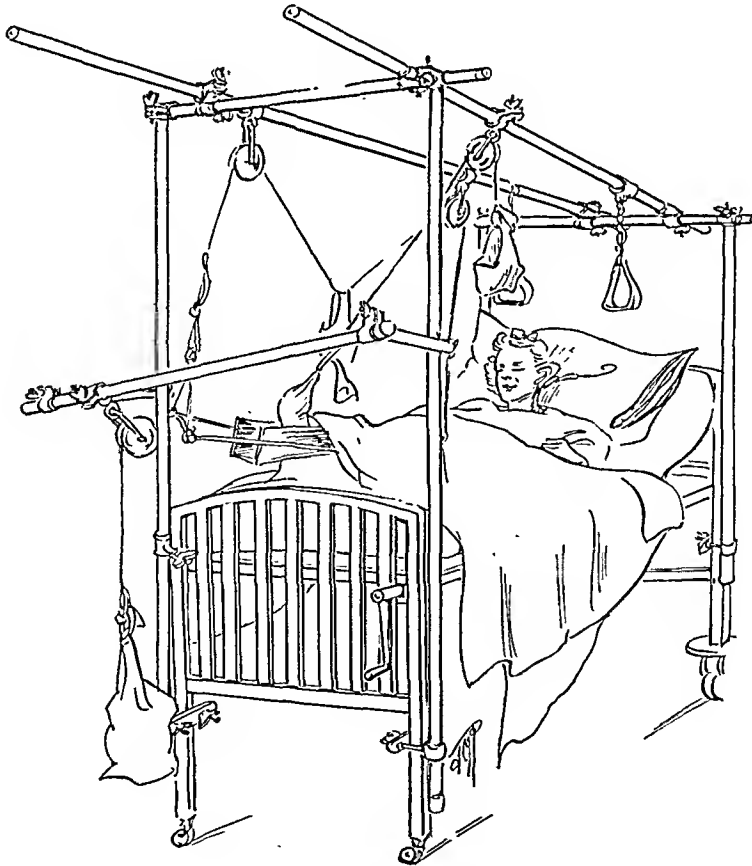
cervical spine. If this fails, the treatment should be augmented by a direct attack on the scalenus anticus muscle.

6. Many cases with mild symptoms will respond to conservative measures. If these fail, the patient should choose treatment either by traction or surgery. The author prefers surgery if not contraindicated.

7. Skeletal traction is an excellent method of treatment for selected cases.

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# MODIFIED OPERATION FOR CARCINOMA OF THE RECTUM WITH PRESERVATION OF THE SPHINCTER\*

LEON S. ALTMAN, M.D. AND BENJAMIN KOGUT, M.D.

Associate Surgeon, Beth El Hospital    Attending Surgeon, Beth El Hospital  
*Brooklyn, New York*

TO many patients life with a colostomy presents unendurable difficulties. Surgery today is well aware of the maximum—preserve the sphincter and save the carcinoma.

the carcinoma and adjacent lymphatic tissue adequately and at the same time maintain intestinal continuity with preservation of the sphincter.

A number of procedures with this end

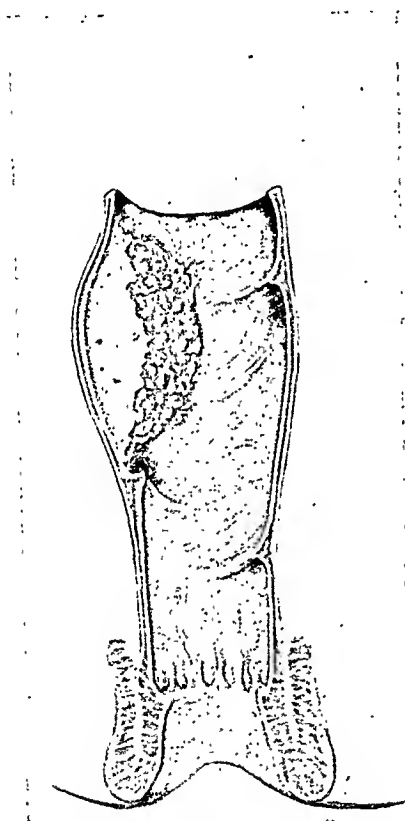


FIG. 1. Carcinoma of rectum in situ.

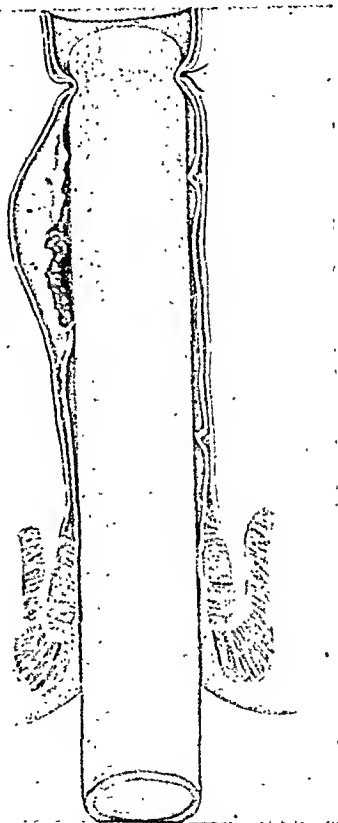


FIG. 2. Catheter in rectum beyond lesion.

There is no doubt that abdominoperineal resection done in either one or two stages is the ideal procedure for the majority of patients with carcinoma of the rectum. However, there are a certain select number of cases of carcinoma of the rectum in which it is possible to remove

in mind have been used with varying degrees of success. For example, the telescoping procedure of Von Hochenegg,<sup>1</sup> the telescoping procedure by the Whitehead method,<sup>2</sup> the Kuttner method,<sup>3</sup> the sphincter preservation method by Bacon,<sup>4</sup> the Babcock method<sup>5</sup> and more recently the

\* From the Surgical Department of Beth El Hospital, Brooklyn, N. Y.



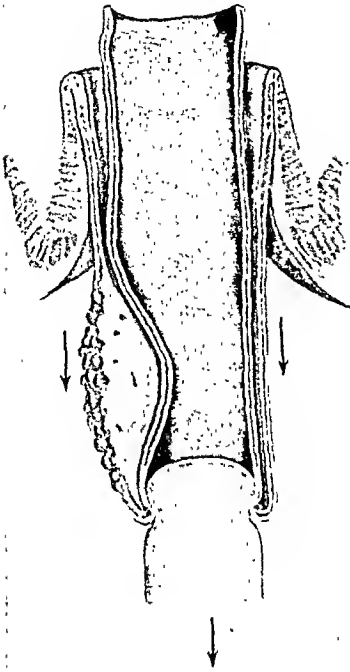


FIG. 3.

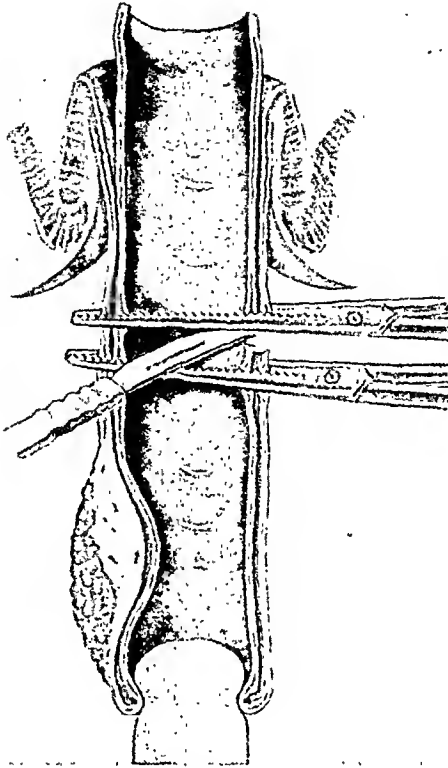


FIG. 4.

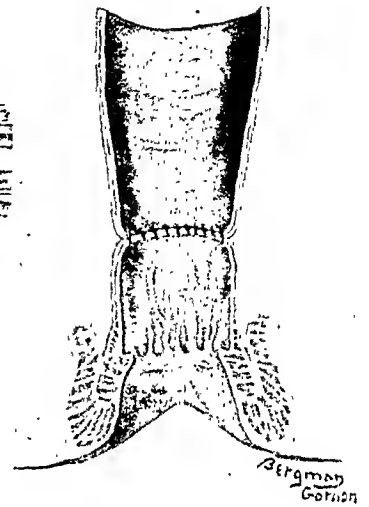


FIG. 5.

FIG. 3. Rectum with lesion pulled out of anus.

FIG. 4. Excision of rectum with growth.

FIG. 5. Anastomosis completed and repositied through anus.

closed anastomosis with ampullary resection as reported by O. H. Wangenstein.<sup>6</sup>

The operation we are about to describe presents all of the advantages of the above mentioned procedures and avoids several of the difficulties and disadvantages inherent in other procedures. There is no loss of sphincter control and there is direct visualization of the lesion. Anastomosis is performed outside the body.

There are three prime requisites: First, the lesion must be small, second, it must not extend beyond the fascia propria (Fig. 1), and third, there must be a mobile sigmoid.

Several days before operation each patient is fed a diet high in carbohydrates and protein and low in fat. Prior to operation the bowel is emptied by repeated colonic irrigations. Sulfasuccidine, vitamins B, C and K are administered. Repeated transfusions are given until the patient's hemoglobin is 85 per cent or over.

#### OPERATIVE TECHNIC

Continuous spinal anesthesia is induced with repeated injections of sodium pentothal introduced into a previously established glucose and saline intravenous infusion.

A right paramedian incision is made with the patient in steep Trendelenburg position. The abdominal portion of the operation is identical to the usual abdominoperineal procedure, namely, dissection of peritoneal flaps lateral to the colon, ligation of the superior hemorrhoidal vessels at the level of the sacral promontory and mobilization of the rectum anteriorly from the bladder or vagina and posteriorly beyond the tip of the coccyx by blunt dissection.

A lap pad is placed in the abdominal wound. The patient is then placed in the lithotomy position. The anus is dilated manually and a No. 28 Babcock catheter

is introduced through the anus to a distance of 8 cm. above the lesion. (Fig. 2.) A suture is placed around the bowel catching the end of the catheter with the suture which is then tied tightly around the gut. (Fig. 2.)

While the assistant guides the bowel from above, it is invaginated through the rectum and out of the anus. This results in an extra-anal intussusception of the lower sigmoid and rectum (intussusceptum) through the anus. (Fig. 3.) This is excised 5 cm. distal to the anus, resulting in removal of the lesion with a portion of normal gut above and below the lesion as well as all gland-bearing tissue. (Fig. 4.) The cut edges are approximated with interrupted sutures going through all layers. (Fig. 5.) The anastomotic site is then repositied through the anus gently. A No. 22 rectal tube is inserted through the anus to a distance of 10 cm. above the site of anastomosis and the tube is anchored to the perianal skin with one suture on each side. A drain is inserted into the perirectal space through a stab wound into the ischiorectal fossa.

The assistant thereupon straightens the sigmoid avoiding undue tension on the line of anastomosis. A new peritoneal floor is made by closing the peritoneum carefully around the sigmoid. An appendicocostomy is done through a small right McBurney's incision to keep the anastomosis at rest, and the abdomen is closed in the usual manner.

*Postoperative Care.* The drain to the perirectal space is withdrawn after decision

that any possible leak in the posterior suture line is not productive of any symptoms. The rectal tube either comes out of its own accord or is removed on the sixth postoperative day.

When a urethral catheter is used, small doses of sulfadiazine should be given daily to prevent any urinary infection. Wangenstein suction is used for forty-eight hours postoperative; 2,500 to 4,000 cc. of fluids and amino acids daily are given parenterally to maintain fluid nitrogen and acid-base balance.

This procedure permits early discharge from the hospital and perfect sphincter control, and obviates formation of rectal fistulas and strictures.

#### SUMMARY

A modified operation for carcinoma of the rectum with preservation of the sphincter is presented for use in selected cases.

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## ERRORS AND EVILS OF EPISIOTOMY

CHANNING W. BARRETT, M.D.

*Chicago, Illinois*

FOR those conditions in which delivery of the fetus is difficult because of the narrowed or deformed nature of the pelvic bones, cesarean section is used with reservation. Within reason and necessity, it is a life-saving operation to both mother and child. The misfortune of obstetric management is that a more serious operation has become popular in order to cater to the doctor's convenience and showmanship and alleviate the patient's fear.

Some of these advantages, even though false, are secured in a time-saving operation of attack upon the continuity of the pelvic floor. Efforts have been made to warrant its common use by a seemingly harmless name, episiotomy, which means cutting of the pubes or vulva structure outside of the abdominal wall. This is an unfortunate error. The pelvic floor structure which lies between the head in the pelvis and delivery is the caudal musculo-fascial lower abdominal wall, composed of five layers of fascia and three layers of muscle. The vulva cut if limited to episiotomy has nothing to do with the question. When the musculo-fascial plates is entirely cut by a side incision, these tissues are cut beyond replacement and injured beyond normal repair.

The vulva and pubes are ornamental structures outside the pelvic floor which impede the head. The plunging of a knife or scissors into this closely constructed musculo-fascial plate obliquely does damage to each of these structures and puts them beyond rational repair by even a fair surgeon, to say nothing of its universal popularity among untrained men. The author has had opportunities of observing these instances from the beginning of its modern popularization. The weak

points have not been confined to the novices. One is not expected to do good work if he does not know the structures which he mutilates, and is not thus true if he is operating nominally entirely outside the so-called pelvic floor in performing an episiotomy while in reality he severs all eight layers of the lower wall of the abdomen.

First, the pelvic floor is seen at times mutilated beyond all repair. Second, the pelvic floor is usually mutilated beyond normal reconstruction in the hands of the performer. Third, the resulting efficiency is decreased from 100 per cent to from 50 to 0 per cent. Fourth, the evils, in addition to these lacks of anatomic and functional faults, are: (1) lack of support; (2) multiple and extensive herniation; (3) infection, scar tissue and fistulas; (4) a high percentage of lack of satisfactory grasp in sexual life, in numerous cases being so unsatisfactory as to threaten a divorce or actually bring it about; proper repair has avoided divorce in the threatened cases; (5) bladder and urethral difficulties have been common and in many cases extensive.

In cases in which a deep oblique incision has been made, leaving that side useless, the author has had the best results by a deep, median and superficial union of the remaining portion of that side of the pelvic floor outside the incision to the deep medium and superficial structures of the untraumatized side. In many cases no structure is found until well out toward the tuberosity on the cut side and on the uncut side the rectum, vaginal commissure and original median perineal region will be found retracted to the uncut side 1 to 1½ inches while this and the paralytic cut side exhibit an expression like Bell's paralysis

which the author has termed the *facies perinei*.

In the interest of useful repair we are in favor of median pelvic floor section to reach a delayed or an impacted pelvic head. Repair is much more sure. After careful delivery I would pronounce tears more amenable to repair than deep oblique incisions.

Marbury and Goldman, in *The Journal of the American Medical Association*, point out their experience with episiotomy in cases of fistula. Cases of this nature have been met in consultation work and would seem almost inevitable in such blind invasion of the deep and complicated structures of the pelvic floor under the name of episiotomy. Either we do a deep and unmanageable operation and call it by a soft spoken superficial name, or we do what the name signifies when it is entirely unnecessary and inadequate; for epis-

iotomy would not dispose of any smallness of the outlet which might exist.

A real enlargement must attack the pelvic floor; and as such an effort cuts through all of the muscles and fascia of the lower abdominal wall, it would be appropriate to term it "a pelvic floor section" which reaches the head in the pelvic abdomen instead of applying a term which has no proper significance. If the median section leaves the two halves of the pelvic floor similar or alike, it renders it amenable to easy and accurate repair by one who possesses knowledge of surgery and the anatomy of the pelvic floor.

A close study of the purpose of languages reveals the extensive efforts which have been made to provide us a careful study of words, and we are remiss in using the term episiotomy for a procedure which does not correspond at all to the meaning of the word.



## MARSUPIALIZATION

### A SURGICAL PROCEDURE FOR THE ERADICATION OF PILONIDAL CYST AND SINUSES

SAMUEL J. FREUND, M.D.  
*St. Louis, Missouri*

AND MARION D. REDDING, M.D.  
*San Diego, California*

THERE are many procedures practiced for the removal of pilonidal cysts and sinuses. The following methods, all of which aim at either the removal or destruction of the cyst wall, are being advocated by surgeons who follow their cases through. The methods are as follows: primary closure, primary closure with drainage, block excision with pedicle flaps, injection of sclerosing agents, local cyst excision and electrocautery.

Marsupialization or exteriorization, a surgical method proposed by Buie,<sup>1</sup> can be used in certain types of infected pilonidal cysts and sinuses. This is not the answer to all types for surgical cure but is another method in the armamentarium of the surgeon. It is indicated particularly, we believe, in pilonidal disease associated with large undermining abscesses and secondary lateral tracts, the extirpation of which produces a tissue defect difficult and dangerous to close primarily.

Pilonidal disease was found frequently in the Services, especially in the young age group. The cause of pilonidal disease is very much disputed but the two most accepted theories of origin are those proposed by Fox<sup>2</sup> and Stone.<sup>3</sup> However, the possibility of the glandular theory, namely, disturbances of the pituitary gland, cannot be overlooked.

The mortality associated with the surgical procedures is practically nil; the attendant period of postoperative disability is prolonged. In private practice we are concerned primarily in obtaining a cure and the length of convalescence is to a large extent of subordinate consideration. However, in the Services, the surgeon must consider (1) estimated time loss from duty, (2) possibility of recurrence and (3) re-

lief of symptoms for as long a period as possible.<sup>4</sup>

Prior to going into the Army, one of us (S. J. F.) had considerable experience with block excision with primary closure while being associated with the late Dr. W. Kress McIntyre. The results obtained from this procedure in seventy-two cases were very good, with only seven patients requiring a second operation. However, time was not an important factor, the operation being more or less elective. Hospitalization averaged sixteen days and loss from work thirty-five days. While in the Service we found that a different problem existed where time in the hospital was an important factor not only in the treatment of pilonidal disease but in every hospital admission. The main reason for this was that when individuals were admitted to the hospital for treatment, they were not to be discharged to duty before being physically fit for field duty. This meant that time not only for operative recovery was to be considered but also the convalescent period. One thing which was never considered, and in many cases a very important item, was the psychiatric make-up of the individual patient.

While in Army hospitals in this country the operative treatment for pilonidal disease was mainly a one-stage procedure—block excision with approximation by catgut or cotton—the results obtained were variable due to the number of different surgeons who had occasion to do the surgery. There was no push for manpower in this country, and to all intents and purposes the care of the individual soldier with pilonidal disease remained elective only to flare up very shortly on his arrival at the overseas destination.

In the E.T.O., we had occasion to treat these patients and the period of hospitalization was a prime factor in the selection of the method of surgery. Operations (one-stage procedures) were performed on individuals who gave a history of recurrence with minimal amount of discharge at time of examination. We found it expedient to use the method of marsupialization in those patients with purulent drainage and in some with acute infection. The results obtained, we believe, were as good as those obtained by other methods.

The principles of the marsupialization or exteriorization method are sound, in that (1) it provides adequate drainage; (2) one conserves the pre-existing skin or, if that has been destroyed by previous inflammation, it preserves the granulation tissue already formed; (3) since tissue is not removed, save for the small portion of the roof, a natural pad over the area is left in place with a result of lessened chance for the appearance of a tender scar and (4) time for convalescence is much lessened.

The individual presents himself with a history of a painful swelling on his "tail bone" which might be the first attack, or he gives a history of repeated attacks with the possibility that at one time the swelling had been incised. Examination reveals an indurated area at the level of the sacrococcygeal junction, in midline, measuring from  $1\frac{1}{2}$  cm. in diameter to 5 cm. in diameter with one or more dimples present in midline. The dimples when probed will be found to go superiorly; and if more than one is found, probes inserted in each dimple will make contact with each other.

Preoperatively the patient should have plain water enemas the night before operation until the returning water is clear. The operative area should be shaved, including both buttocks, the upper thighs and the perianal skin. Medication should consist of a sedative the night before and two hours preoperatively, morphine and atropine to be given forty-five minutes before operation.

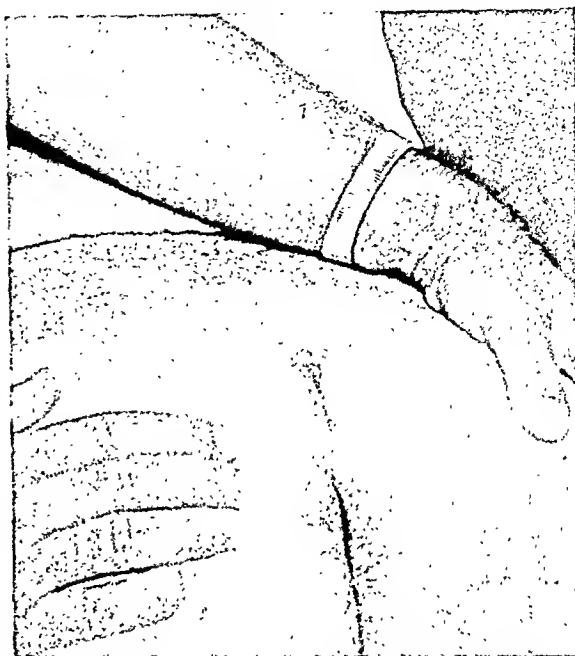


FIG. 1. Marsupialization fourteen days postoperatively.

The patient is then brought to the operating room and a spinal anesthetic is administered. We have found that the patient experiences less after pain and discomfort from a low spinal anesthetic than from any other anesthesia. The patient is then placed on his abdomen and at least ten minutes are allowed to elapse before anything further is attempted. The area is then cleansed with ether, alcohol and an antiseptic, and the drapes arranged.

The grooved director is inserted in the superior dimple as far as it will go and then the overlying skin is incised. The grooved director is then placed in successive inferior dimples and the overlying skin is incised. It will then be found that all the dimples coalesce either subcutaneously or from the abscess cavity. An Allis forceps is placed on either side of the incised skin, traction is placed on the cut surfaces laterally and the abscess cavity is probed in all directions for subterranean tracts. The picture is that of a granulative wound; in some cases hair or gelatinous products are present in the abscess cavity. The cyst wall is then wiped dry with a dry sponge and the abscess wall is evident. Using a curved scissors, the overlying skin is excised at

approximately the outer edge of the abscess cavity. Small hemostats are applied to the bleeding points and the skin is then approximated to the base of the cyst wall either with a running suture of catgut or interrupted sutures of cat gut or non-absorbable suture. Sulfanilamide powder is dusted onto the wound and vaseline gauze applied over this; a gauze dressing and then an adhesive binder are applied.

The patient is returned to his room and lies on his abdomen. A liquid diet is allowed after the first day and this is gradually increased until a regular diet is taken on the third postoperative day. The dressings are removed on the third or fourth postoperative day and hot sitz baths instituted; the wound is protected by vaseline gauze between soakings.

After five to seven days the sutures have either disappeared or are removed and the reddened surrounding area has returned to normal. The line of suture uniting the cyst wall and skin reveals firm union. The patient leaves the hospital on the eighth day and continues taking the sitz baths until the wound is healed. A regular diet is followed and the patient is advised not to take any athletic exercise. At the end of two weeks he may return to

his work provided it is not of a strenuous nature.

Within a short time after this a transition occurs in the secretory function of the epithelial lining which gradually lessens and appears as a dry, shiny surface. After four weeks, and in some instances less, the operative site is marked by a purplish line with practically no depression of the marsupialized remnant and adequate padding by subcutaneous fat over the sacrococcygeal area.

#### CONCLUSION

In conclusion we are proposing that marsupialization, a method for the surgical removal of pilonidal cysts and sinuses, be used more in the future. The method is simple, hospitalization is decreased, the patient while convalescing is unrestricted in his movements and complications are minimal.

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# INSERTION OF THE SMITH-PETERSEN PIN\*

MARTIN L. QUINN, M.D.

Assistant Surgeon, St. Johns Long Island City Hospital  
Woodside, New York

NOT infrequently we have seen a person past middle age admitted to the ward with so-called surgeon's headache or the previously unsolved fracture, namely, "fracture of the neck of the femur." In many institutions even today, particularly if not urbanly located, the proverbial spica cast is applied. After a few days or a week a pneumonic constipated person is found in a soiled, soggy, wet cast. In another two weeks x-ray shows slipping and coxa vera deformity due to a loose cast occasioned by reduction of swelling, muscle atrophy and weight loss. It is for these reasons, as well as others, that a plea is made for more general use of the Smith-Petersen pin or other fixative agents.

Historically, the first fracture of the neck of the femur was recognized by Ambroise Pare who lived in the era between 1510 and 1590. He initially confused it with a dislocation. The first fixation was done by Von Langenbeck in 1858 using a nail for fixation. Others followed with different types of nails, spikes and screws until in 1912 Dr. Fred Albee used autogenous bone grafts. In 1934, Gaenslen used rustless steel spikes  $\frac{3}{32}$  of an inch in thickness. All used splints of some sort. Dr. Smith-Petersen in 1931 devised a pin bearing his name and he employed the intracapsular approach.

The injury is slight and indirect. Often an ordinary twist of the hip causes the fracture with the resultant fall, and not vice versa, so that in a few moments an elderly individual is transformed from a self-sufficient creature to a pitiful, helpless heap. Bilateral femoral neck fractures have been known to occur with con-

vulsive therapy, such as shock-induced treatments.

The type of fracture determines the prognosis. The nearer the fracture is to the base of the head the less the vascularity, the poorer the healing, and the longer the non-weight-bearing period will be. To this it should also be added that the better the nailing the more effective the result. According to location, intra or extracapsular types are known as well as whether or not they are subcapital, transcervical or intertrochanteric. A less known division is the adduction type in which the fracture line tends to be vertical through the neck, and the abduction type in which the fracture line is obtuse or more horizontal. In the former, shearing of the fragments occurs and there is more displacement and poorer healing. In the latter the weight-bearing plane is nearer normal and if displacement is minimal, no fixation or reduction is necessary because it will heal without either as it tends to impact itself.

Femoral neck fracture is an exception to the dictum that most all fractures are emergencies, apropos, of course, of pinning. Immediate immobilization is imperative, either by tying both feet and legs together or by the use of a long wooden splint with a triangular bandage in the groin tied to the notched top and traction from the tied foot to the notched bottom or the usual Thomas splint. Upon hospitalization some traction with weight may be added to overcome muscle spasm and relieve pain. Shock is treated from the beginning. Negative water balance, plasma proteins, cardiac decompensation, diabetes, pneumonia and possible traumatic alcoholic psychoses are considered with competent medical con-

\* This paper was presented at the Queensboro Surgical Society in November, 1946.



sultation. Usually within two to four days the patient is ready for operation. Sulfadiazine is given prophylactically. The immediate preoperative preparation includes emptying of the bowel and bladder, shaving of the lower abdomen and hip area, allowing fluids up to four hours before operation. Three gr. of nembutal or seconal is given two hours before taking the patient to the operating room. Sips of water are permitted on the table providing there is no tendency to nausea or vomiting.

The preferable anesthesia is spinal, using 15 mg. of pontocaine or 200 to 300 mg. of neocaine. This is given in the fourth lumbar space with the patient lying on his side. If necessary, sodium pentothal may be supplemented. This amount of anesthesia will be sufficient, if necessary, for two hours of work.

Hip pinning may be done by any competent operator. Naturally it is presumed that one has an anatomic knowledge of the area involved so that one at least respects and is tolerant of commonly accepted rules of procedure. After a third or fourth case they are relatively simple.

To save time, which in these cases is lost waiting x-ray development, reduction of the fracture is not accomplished until the patient has been given the anesthesia and is draped. The patient should be in the supine position, with an x-ray cassette tunnel placed under the involved hip with its open end directed to the opposite or uninvolved side. In this way the drapes are not disturbed on the operative side when taking the films. Antiseptic painting includes the lower abdomen, operative site, groin, buttock and thigh to the mid-leg. A sterile pillowcase envelops the foot and leg to below the knee and is closely tied by a sterile bandage. No metal clip is necessary to hold the drapes within the anteroposterior or lateral x-ray views.

Reduction of the fracture is accomplished by Leadbetter's method which is as follows: The hip is flexed to the right angle and lifted up before it is internally rotated, abducted and then extended.

During this maneuver the pelvis is held firmly on the table by an assistant. When the leg is extended, traction is applied by the assistant so that coxa valga or as near to that position as possible is maintained. The foot is held in inversion. This maneuver will reduce all fractures when early diagnosis and reduction has been made. Those with fractures that have been neglected for one to four weeks will need a more rotary motion and pull in the direction of internal rotation. Loud crepitus is heard in reducing a fracture over a few weeks old. The Leadbetter method is so positive in the early cases that no radiographic check is necessary until the guide pins have been inserted. When the patient's heel is held in the palm of the hand and there is no tendency to lateral rotation of the foot beyond approximately 15 degrees and the length is comparable with the normal leg, the fracture is said to be reduced. This is known as the heel-palm test. On the other hand, when the foot moves out to more than 50 per cent lateral rotation, the fracture is not reduced. The distal part of the neck lies posterior to the proximal part and it is pulled upward by the biceps femoris, psoas and hamstring muscles. In cases which are of four to five weeks' duration, reduction should be attempted followed by x-ray in the anterior and lateral views before painting, draping and insertion of the guide wires. If reduction is not accomplished, intra-articular reduction and nailing is indicated in which case there is further vascular interference and surely more chance for avascular necrosis of the head. This is rare in extra-articular fixation. Leadbetter's method is definitely contraindicated in intertrochanteric or pertrochanteric fractures. A new fracture will ensue in the shaft at the level of the lesser trochanter.

The incision should be approximately 4 to 5 inches in length over the greater trochanter, extending through skin, superficial fascia, tensor fascia femoris and vastus lateralis fascia. A point 1 inch below the lower mid-border of the greater tro-



FIG. 1. Transcervical femoral neck fracture.



FIG. 2. Reduction and insertion of two guide wires.

chanter on the lateral surface is selected and two heavy Kirschner wires, 9 inches long, are inserted into the neck for about 4 inches at slightly upward angles, being placed at a 45 degree angle to the shaft and with an upward inclination of 15 degrees. This can be accomplished by the eye or by countless other devices and gadgets. One of the best is the Engle May direction finder. Watson-Jones uses a short guide wire with a handle attached after gouging out a  $\frac{1}{4}$  inch opening in the bone. It is important that the leg be held with some traction and the foot inverted and maintained in this position. Dr. Nicola has the feet held by an assistant with both great toes markedly inverted which brings the femoral neck on each side to a horizontal plane. In this way the pin need not be tilted 15 degrees upward upon its insertion. Some men use leg holders, the thigh being held in abduction with a levelometer attached to maintain inversion of the femur. However, there is always a possibility that this might slip and interfere with circulation.

It is at this point that the first x-rays should be taken, anteroposterior and lateral views. One or the other guide wire is usually in good line with the reduced fracture. If this is not the case, the unsatisfactory one is removed and another is inserted to make an attempt at improvement of the position of the good wire. A repeat x-ray is done for a check, or omitted if sufficient experience has been had with this work. The guide wires should extend to the articular surface of the head but no great harm will result if it is accidentally penetrated. This is done so that on driving the Smith-Petersen pin over the guide wire there will be no tilting of the head or proximal fragments. This could occur to 45 degrees with the first impact of the hammer. The x-rays having been taken the Smith-Petersen pin, usually  $3\frac{1}{4}$  to  $3\frac{1}{2}$  inches, is threaded over the most satisfactory guide wire and inserted the full length. This is done only when the poorly inserted guide wire is removed. To insert the pin with both guide wires left in place is not good technic because

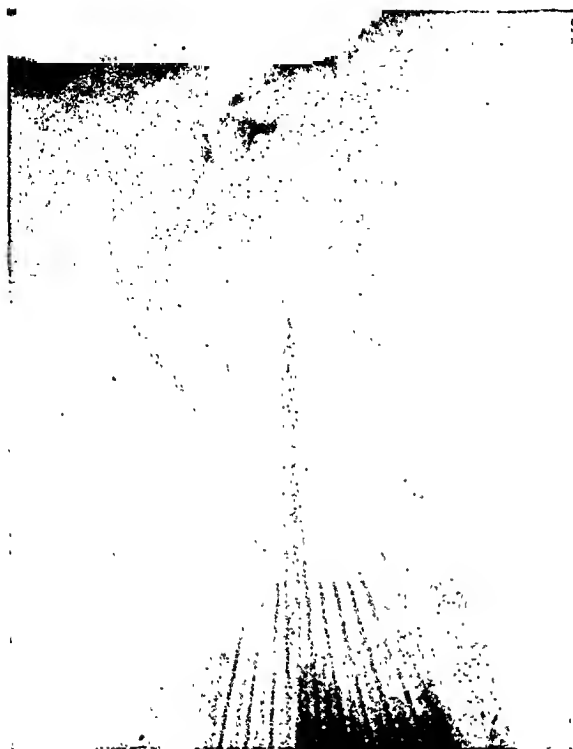


FIG. 3. Lateral view of guide wires in Figure 2.

the unused wire is apt to be bent and cause a great deal of difficulty in removal. Watson-Jones and Kellog Speed insist upon accurate insertion and accurate size of the pin. However, the author sees no reason for this mathematical accuracy as illustrated in the accompanying x-rays. (Figs. 1 to 10.) Surely the pin must not penetrate the head or even be too near its articular surface. One-quarter of an inch is close enough to allow for some absorption of the neck or the adjacent fractured surfaces which become necrosed, liquefied and absorbed. As the nail is driven in care should be taken to see that the guide wire does not go in with the nail as the latter is inserted. It is important to always stop  $\frac{1}{2}$  inch short of the cortex of the shaft with a  $3\frac{1}{4}$  inch nail, then removing only the second or final wire. When the next x-ray is taken, it can be driven in a little further in the process of impaction.

Some operators say that impaction is not necessary. It is an accepted fact that impacted fractures heal better than those which are not impacted. After the final



FIG. 4. Insertion of the pin, anteroposterior view.  
FIG. 5. Insertion of the pin, lateral view.

x-rays are taken and before the wound is closed every fracture should be impacted, the amount being apparent. Naturally there is some impaction with each blow of the hammer but with the impactor instrument it can be increased according to the force of the blow. There is no reason for attaching an extra nail from the end of the pin to the shaft of the femur to prevent slipping. If there is any neck shortening, penetration to the joint is more apt to take place. Overlapping and close



FIG. 6. This type of pin approaches an abduction type fracture.



FIG. 7. The pin is too low in the neck as well as too horizontal.

suturing of the fascia over the end of the nail will tend to prevent slipping. A final x-ray is taken in two views and the wound closed without drainage using continuous chromic No. 1 for the fascia and well spaced, interrupted black silk for the skin. No splint is applied to the leg, above all a spica, which defeats one of the purposes of the pin. The only exception may be the application of a one-sided spica for a month or two if, in the final x-ray, the lateral view demonstrates that the pin is off center and close to the edge of the neck. Finally all motions are tested by moving the leg and thigh freely and gently.

The patient is returned to bed and the leg placed on a pillow with the usual post-operative care of the bladder, pain, water balance, encouragement of deep breathing as well as general nursing care. After a few days quadriceps muscle exercise is encouraged and at the end of a week full flexion of the knee is possible. Chemotherapy is continued for at least a week at which time the patient may use a wheel

chair. Crutches may be used as early as is commensurate with the strength and agility of the patient.

As to weight bearing the more experienced concepts should be accepted. No fracture is completely healed until the fracture line is no longer visible. The minimum for this fracture is six months; the maximum a year or even two. Dr. S. Kleinberg allows weight bearing in about a month. He uses the Thompson "Z" nail by direct visualization, intracapsularly. This nail can be cut with shears, it is not as strong as the Smith Petersen pin and also the blood supply is further lessened by open capsular approach.

Healing depends upon the blood supply as well as approximation by pin fixation. The head and neck of the femur are vascularized in four ways: (1) diaphysial, through the nutrient artery of the femoral shaft; (2) periosteal, through vessels in the periosteum from innumerable fine branches of any artery near it; (3) epiphyseal, this is the capsular group from the anterior and



FIG. 8. This depicts neck absorption but it is a live flattened head.

posterior circumflex arteries from the profunda; (4) the ligamentum Teres group, namely, a branch of the posterior division of the obturator artery. The ligamentum teres is attached to the fovea centralis of the head and this anatomic area is located in all femoral heads in the lower posterior part. Perforation of this structure with the pin, causing vascular destruction, is possible but improbable due to the 15 degree upward tilt taken on inserting the pin. Interference with any one source will result in a disturbance of bone metabolism proportionate to the importance of the supply affected. This factor is a most important one since it concerns bone regeneration. Most of these fractures are very irregular and comminuted; it is never a straight through fracture. Therefore, the repair is more involved and extensive, including necrosis, decalcification, liquefaction, absorption, granulation and calcification.

What size nail should be used and how far should it be inserted? This depends on

two things: the length of the femoral neck and head, and the distance below the greater trochanter that it is inserted. The distance in any femur from the articular surface of the head to  $\frac{1}{2}$  inch below the greater trochanter varies in adults from  $3\frac{1}{2}$  to  $4\frac{1}{4}$  inches. If the technic of the operator is one in which he inserts the pin 1 to  $1\frac{1}{2}$  inches below the greater trochanter, then he must use a longer nail, especially so if he is dealing with a subcapital or high neck fracture. Otherwise, the pin will not be sufficiently within the head or proximal fragment. The aforementioned is considered good technic because of the more vertical line of stress and strain. A  $3\frac{1}{4}$  inch nail is sufficient, believing it possible to bury it beyond the cortex of the shaft if necessary.

Engle May calculates the distance of the neck accurately by proportion, namely, the ratio of the actual length of the direction finder is to its length on the x-ray plate as the actual length of the femoral neck (which is X) is to the length of the neck on the x-ray. Another method for calculating the size pin to use is knowing the length of the guide wire inserted (9 inches), how much of it is in the bone and how much is out and subtract the difference. This method holds only if the wire is inserted approximately  $\frac{1}{4}$  inch from the articular surface of the head. And again, another  $\frac{1}{4}$  inch must be allowed for impaction or the absorptive process at the fracture site.

When the x-ray is taken at the time of the accident, it should include both hip joints so that an estimate can be made of the relative size and length of the neck and also the amount of normal coxa valga. During the pinning, anteroposterior and lateral views are imperative, otherwise one does not know if the pin is truly in the neck. Anteroposterior views are easy to interpret but to read properly the lateral view the plate must be held so that the shaft is horizontal and the neck and head extend upward at an angle. It is confusing in the calculations to have the neck and

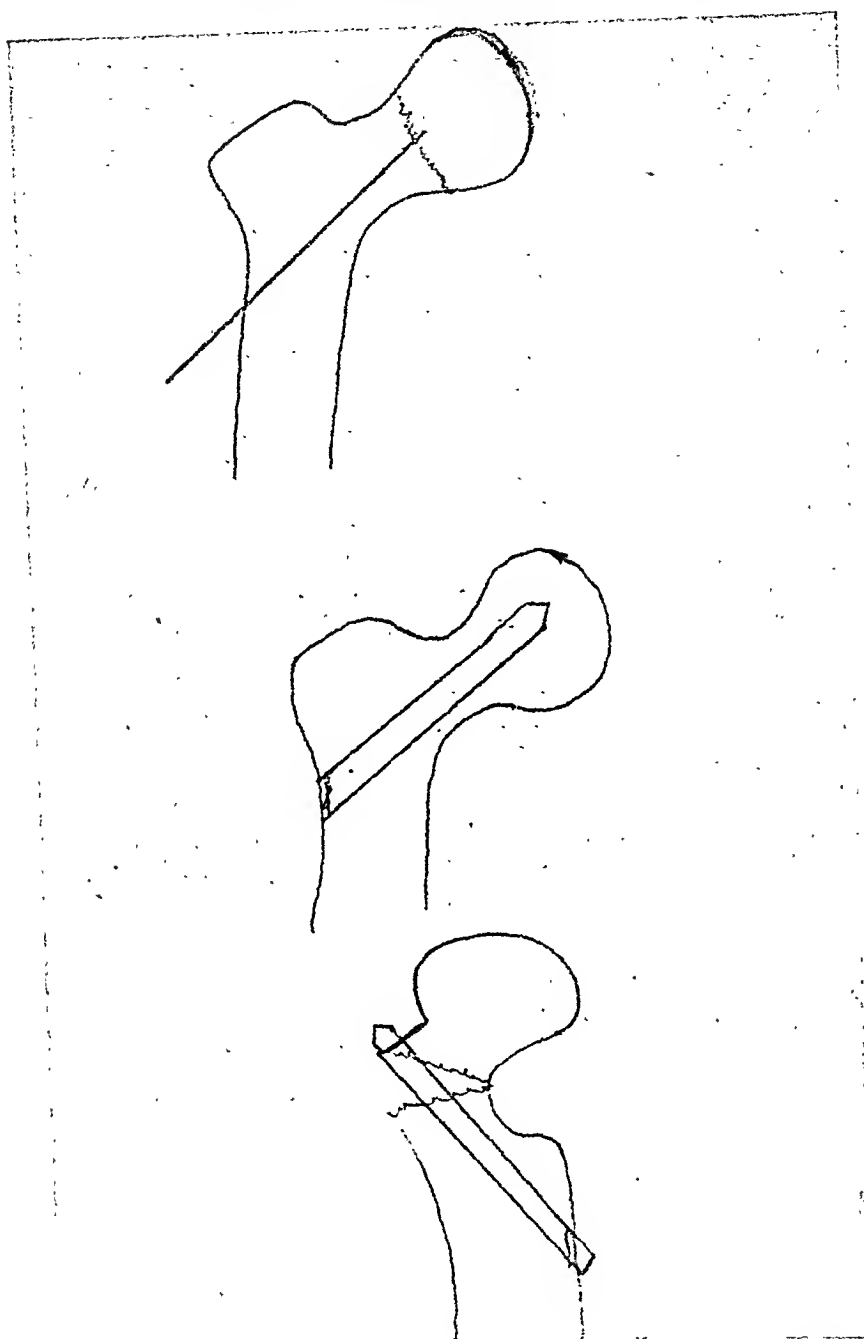


FIG. 9. Drawing showing why the guide wire must be inserted to the articular surface of the head.

head point downward because the inclination is upward 15 degrees. The x-ray must be clear, especially in the lateral view and should include all of the head, neck and adjacent shaft. So as not to be confused with the guide wires in the lateral view the Engle May direction finder is slipped through one of them and faces the x-ray cone and tube. The use of any more than

two guide wires is apt to be confusing, particularly on the lateral view. It is not necessary to move the involved leg during the procedure. When the lateral view is taken, the cassette, enveloped in a sterile pillowcase, is put in line with the femoral neck, the edge being placed against the rib margin and the patient holding his breath when the picture is taken. Films

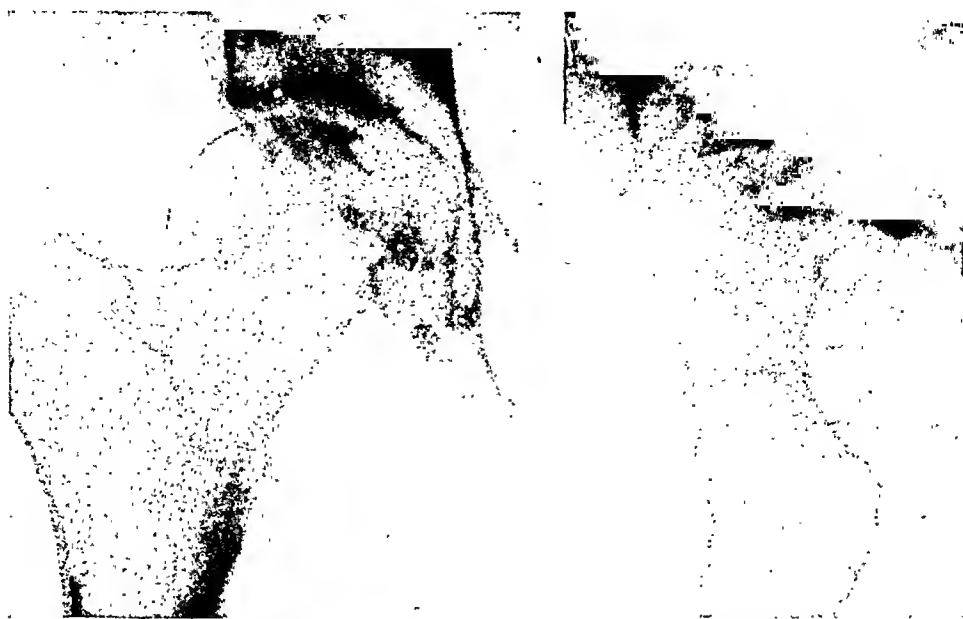


FIG. 10. Illustration showing an abduction type fracture in which pinning is unnecessary.

processed by the portable developer are time-saving but they must be clear. They are not permanent plates. The position should be checked once a month for the first three months, then every two months thereafter. The fracture line must be obliterated, being bridged over by new bone, before weight bearing is allowed. It should be remembered that in order to show all of the femoral neck on the film without distortion the foot must be inverted.

Any operation has its complications. So, also, hip pinning is associated with decubitus, pneumonia and wound infections. These are prevented, if possible, and treated as indicated. The Smith-Petersen pin is a three-flanged nail made of Vitalium. It does not have to be removed unless there is bone infection; then the more quickly removed the better, followed by osteotomy when the process has sufficiently healed. If a small edge penetrates the head slightly, it need only be removed when healing is complete unless this situation causes symptoms. If there are any flaws in the pin, there is apt to be erosion, necrosis and ionization at the site.

Use of the Smith-Petersen pin, as a rule, is attended with excellent results. In 85

per cent of the cases which are pinned, good union is obtained. Barely 40 per cent have good union with the Whitman spica method. In the few cases in which non-union and absorption result, bifurcation osteotomy or other bone operation must be resorted to. These cases are those that have the pin inserted by opening the capsule to note direction and reduction and those cases in which the blood supply has been markedly interfered with at the time of injury.

#### SUMMARY

The method is described for the accelerated introduction of the Smith-Petersen pin for fractures of the neck of the femur. This may be divided into different stages.

1. Care of the patient from the time of the accident to operative intervention.
2. Anesthesia, reduction by Leadbetter's method, incision and insertion of the guide wires.
3. The first operative x-rays with one guide wire left *in situ*.
4. Insertion of the cannulated Smith-Petersen pin over the guide wire, the former being driven to a point about  $\frac{1}{2}$  inch of the lateral cortex of the shaft and to within  $\frac{1}{4}$  inch of the articular surface of the head.

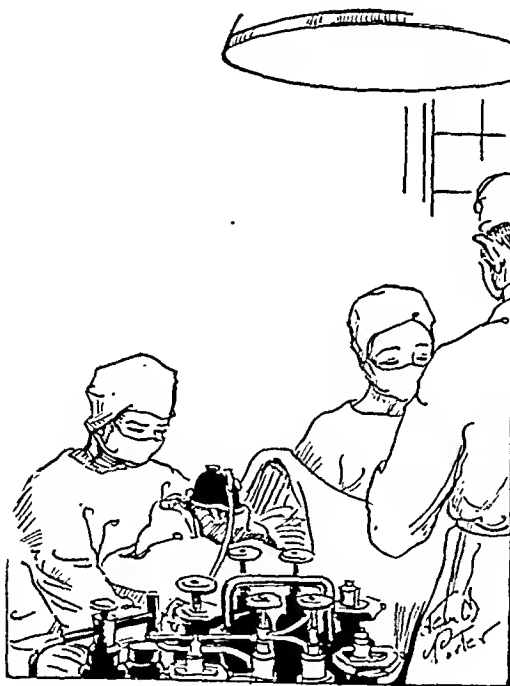
5. Removal of the guide wire, final x-rays, impaction and closure of the wound.

6. Rules and reasons are given for healing and weight bearing.

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# TREATMENT OF HEAD INJURIES AND THEIR SEQUELAE\*

WILLIAM P. E. BERWALD, M.D.

Senior Physician and Surgeon, Patton State Hospital  
Patton, California

AS Loyal Davis has said: "Craniocerebral injuries are no longer a problem whose solution is reserved for the neurological or general surgeon." It is obvious that in this day and age every physician in every locality will at one time or other be called upon to treat a patient with craniocerebral trauma. The manner in which the patient is treated is all important and while frequently determining survival or decease of the patient, always determines his future value to society. The occurrence of the post-traumatic concussion syndrome is all too frequent, is disastrous to family and industry and is almost always avoidable, or if already present, curable.

Skull fractures are unique among fractures of other bones of the body in that the fracture itself is usually relatively unimportant. The damage to the underlying brain demands primary consideration. An exception to this statement is the compound, comminuted or depressed fracture when débridement or elevation must be performed as soon as the patient's general condition will permit it. Obviously no set regimen of therapy is applicable to all cases of a given descriptive mold and it follows that each patient must be carefully individualized. For therapeutic purposes, however, some classification is desirable and is best made, in my opinion, on the varying degrees of severity of brain damage. The first subdivision would obviously be the presence or absence of subsequent unconsciousness. Inasmuch as the physician rarely sees a patient initially who has not been rendered *unconscious* from a head trauma, we will pass over this division and consider it later with the postconcussion

syndrome, which condition it is capable of producing. We can now consider the remaining subdivision, i.e., the head injury which has been severe enough to produce unconsciousness. By and large, the degree of cerebral trauma is in direct ratio to the length and depth of unconsciousness. The length may vary from a few minutes to several weeks. For descriptive purposes we can further subdivide the unconscious patients into categories of cerebral concussion, contusion and laceration in the order of severity. Cerebral concussion has been defined as a state of altered consciousness that occurs in association with sudden acceleration or deceleration of the brain, or a disturbed physiologic state for which there can be found no definite anatomic substratum or at most minimum cellular alterations. Loyal Davis has described it as a mechanical derangement of molecules within nerve cells. It is common knowledge that a sufficiently severe blow on the head may produce a concussion from which a person will die without there being any associated skull fracture and in many of these cases neither macroscopic nor microscopic examination has produced sufficient evidence of the cause of death. In most of these cases, however, there is edema of the brain tissues. When even the latter cannot be demonstrated, it must be assumed that the resulting molecular shake-up of the neuroncytoplasm produces some chemical change in the nerve cells which is sufficient to interfere with the conduction of the nerve impulse.

In uncomplicated cerebral concussion a diagnostic lumbar puncture will reveal a clear spinal fluid under normal or increased pressure.

\* Read before the Utica Academy of Medicine, Utica, N. Y., January 16, 1947. Read before the Syracuse Academy of Medicine, Syracuse, N. Y., February 18, 1947.

Before proceeding to a definition of the more severe degrees of craniocerebral trauma it might be well timed to consider the contracoup type of injury. This injury, which is by no means infrequent, is seen at the pole of the brain which is diametrically opposite to the primary site of injury. The chief lesion at the site of a contracoup injury is subarachnoid hemorrhage, and also there are usually small pericapillary hemorrhages and edema of the underlying cortex. Cerebral contusion implies a bruised brain, with moderate bleeding into the subarachnoid space and a normal or increased spinal fluid pressure. Cerebral laceration implies a torn brain, with gross bleeding into the subarachnoid space and almost invariably a considerably elevated spinal fluid pressure.

A type of cerebral laceration in which there is bleeding into the substance of the brain will produce a softening which will favor the subsequent occurrence of rather massive hemorrhages. These may cause death in a patient who has survived the initial traumatic laceration, or may form traumatic cysts by liquefaction of the necrotic brain tissue. These complications are more common in children and may simulate true porencephalic cysts which are of developmental origin. Traumatic cysts, however, are not lined by ependymal epithelium. It follows then that the color and pressure of the spinal fluid are important clues to the extent of brain damage and a diagnostic lumbar puncture should never be omitted in a patient unconscious from a craniocerebral trauma. All three degrees of cerebral trauma are accompanied by a greater or lesser degree of cerebral edema. Cerebral edema is due to an increase of tissue fluids within the brain. It is recognized macroscopically by increase in brain volume, convolutional flattening, increase in the volume of white matter, narrowing and compression of the gray matter, ventricular compression and possibly ventricular shift. Microscopically, brain swelling and edema are characterized by hydration and swelling of the axis cylinders,

myelin sheaths and glial cells, distention of the perivascular and pericellular spaces, congestion and engorgement of the capillaries and veins, ameboid degeneration of the astrocytes, endothelial necrosis and liquefaction of the nervous tissue. The edema is presumably due to the transmitted force of the trauma causing vasoparalysis of the capillaries and venules, thus producing an increased venous pressure and an actual reversal of the normal direction of fluid exchange. A local accumulation of carbon dioxide resulting from this will lead to further vascular dilatation and increased permeability of the vessel wall. The developing edema further retards circulation and a vicious circle is formed.

If the aforementioned facts are borne in mind, the rationale of the dehydration treatment of craniocerebral trauma will readily be appreciated.

Treatment of a patient suffering from a craniocerebral trauma resolves itself first into the treatment of shock, if it is present, and secondly, into management of the brain damage itself.

Since the treatment of shock is well known, we will only state that the currently popular product used to combat shock, viz, blood plasma, is the best cerebral dehydration agent we know of, being far superior to hypertonic solutions of dextrose or sucrose. After the shock is under control and all bleeding has stopped a cursory neurologic examination is in order. The size, equality and reaction of the pupils to light should be noted. A dilated pupil, fixed to light is frequently present on the side of maximum injury or bleeding. The escape of blood or spinal fluid from the orifices is frequently indicative of a basilar fracture. The state of the abdominal reflexes plus the sign of Babinski will often determine the side of maximum damage. In a case of severe concussion, contusion or laceration it is not unusual to find bilateral pyramidal tract signs. The relationship of the pulse pressure to the pulse rate is of significance. When the former exceeds the latter, it is a grave sign and decompression either medi-

cally or surgically is indicated. A skull ray is very valuable and should be taken provided that adequate x-ray facilities are available and it does not require rough handling of the patient. The next step is a diagnostic (and sometimes therapeutic) lumbar puncture. This procedure should never be attempted unless the patient is quiet. If he is delirious or unmanageable sodium luminal in doses of 2 to 6 gr. hypodermically, or sodium amytal gr. 3¾ intravenously may be given and the puncture done after the drug has taken effect. While taking the initial pressure, the patient's head should *not* be bent forward as this increases the pressure. The Queckenstedt test should never be performed while doing a spinal puncture on a patient suffering from a craniocerebral trauma. It adds no useful information and may actually be dangerous if the spinal fluid pressure is elevated since it favors medullary herniation. The normal spinal fluid initial pressure is between 100 and 200 mm. of water. If it is above 200 mm., enough fluid should be withdrawn slowly to reduce the initial reading 50 per cent or more. If the patient coughs or strains during the procedure, the stylet should be replaced and the physician should wait a few minutes before withdrawing any more fluid. The fluid, if bloody, should be kept on the floor to be compared with subsequent specimens. The frequency of lumbar punctures will depend upon the patient's general condition, height of the spinal fluid pressure, amount of blood in the fluid and the rate at which fluid limitation and administration of dehydrating agents can reduce the brain swelling. Almost never is it necessary to tap a patient more than twice a day and after twenty-four to thirty-six hours once a day should be adequate. Even after the spinal fluid pressure has stabilized at a normal or subnormal value, lumbar puncture should be performed daily or every other day as long as the fluid is bloody. Daily lumbar puncture is warranted from the symptomatic standpoint alone, not only in subarachnoid hemorrhage of traumatic origin but also

in spontaneous subarachnoid hemorrhage since many patients are greatly relieved of their headaches following the puncture. If a patient is limited to as little as 750 cc. of fluid in twenty-four hours, he will not make any spinal fluid and after two or three days you will encounter a dry tap. The only traumatic condition in which lumbar puncture is dangerous is massive intraventricular hemorrhage and this condition is usually fatal in itself. The value of lumbar puncture on the other hand, not only diagnostically but therapeutically, can readily be appreciated when one considers that of all the intracranial contents, the subarachnoid, cistern and ventricular fluid is the only component which is unnecessary for normal brain function, at least under the conditions in which one would find a patient unconscious from a craniocerebral trauma. The subject of lumbar puncture has been discussed at some length to dispel the current naive fear of this valuable and frequently life saving procedure.

To further reduce cerebral edema the employment of hypertonic solutions intravenously is used. As previously mentioned blood plasma is the best and may be administered in quantities of 250 to 300 cc. at eight-hour intervals. If this is not available, 50 to 100 cc. of 50 per cent sucrose or sorbitol is next preferred or, if unavailable, the same quantity of dextrose at four to six-hour intervals. The employment of hypertonic intravenous dehydrating agents are of most value when given early and become less important after twenty-four to thirty-six hours since by this time the fluid limitation itself has begun its function of dehydration. Oral administration of dehydrating agents also has its place in reducing cerebral edema and may be employed as soon as the patient has responded and is able to swallow. The drugs we prefer are magnesium sulfate crystals, ounces 1½ in ½ a glass of water, or Fleets phosfo-soda, drams 6, in the same amount of water. We prefer not to repeat this more often than once daily since the resulting catharsis is rather exhausting. Temple Fay has ad-

vocated a fluid restriction of 750 cc. per twenty-four hours. We believe this is too drastic a limitation since some of our patients have developed an alarmingly high blood non-protein nitrogen on this regimen. We rarely limit the fluids to less than 1,000 cc. per twenty-four hours, and while a small amount of cerebrospinal fluid will be formed it is insufficient to raise the intracranial pressure. The fluid limitations should be observed for several weeks since we have found that the post-concussion syndrome is much less likely to occur than when unrestricted fluids are allowed with the regaining of consciousness. The triad of lumbar puncture, intravenous administration of hypertonic dehydrating solutions and fluid restriction is the warp and woof of the dehydration treatment of craniocerebral trauma and has saved untold numbers of lives.

To pass from specific therapy to general therapy we may first discuss the position of the patient. If the patient is not in shock, the ideal position is one of semi-Fowlers. The intracranial pressure is slightly lower in this position and there is less intracranial bleeding. Care should be taken that the patient has an adequate air way at all times. Suctioning the pharynx of mucous, blood or vomitus and keeping the tongue from falling back due to weakness of the pharyngeal muscles by either turning the patient's head to the side and pulling the tongue out, or by using an airway will insure adequate aeration. Proper consideration must also be given the bladder. A violently delirious patient can sometimes be made as docile as a lamb by the simple measure of catheterization. A wet bed is no guarantee of an empty bladder and, when in doubt, catheterization for residual urine should be carried out. Bleeding or dripping of spinal fluid from the ear is best managed by cleansing the external auditory meatus with sterile cotton and then placing a sterile cotton pledget moistened with alcohol loosely in the meatus. This is changed frequently. These patients should receive 1 Gm. of sulfadiazine four times daily

prophylactically for approximately a week to avoid the complication of septic meningitis. Penicillin offers no advantage over the sulfa drugs for this prophylaxis.

The feeding and maintenance of a fluid balance in an unconscious patient, while not peculiar to head trauma cases, is perhaps more frequently met with under these circumstances. Patients unable to take fluids orally may be given intravenous infusions of 10 per cent dextrose in sterile distilled water. This solution has a small caloric value and avoids the sodium ion thereby discouraging tissue fluid retention. Fifty per cent glucose may be used both for nourishment and dehydration. The injectable amino acids, such as parenamine, may be given in quantities of 100 or 200 cc. in 500 to 750 cc. sterile distilled water with or without 5 per cent glucose intravenously twice daily. If the unconsciousness lasts more than a day or two, the best procedure is to insert a Levine tube and administer fruit juices, egg nogs, etc. Medications, such as pyramidon in 10 gr. doses, may be given through the tube to combat an alarming hyperthermia. The latter condition may also be treated by applying ice caps to the axillae and groin and also by ice water enemas.

The sedative drugs to be used are codeine, by mouth or hypodermic in  $\frac{1}{2}$  to 1 gr. doses, sodium luminal hypodermically in doses of from 2 to 6 gr. and sodium amytal intravenously in  $3\frac{3}{4}$  gr. doses. All these may be repeated in from two to six hours. Morphine, pantopon or dilaudid are never given to patients with head injuries since they depress the respiratory center, increase cerebral edema and mask the degree of consciousness. We have used demerol in doses of 50 to 100 mg. orally or hypodermically in a few cases without observing any deleterious effects.

The period of bed rest is another problem which must be individualized, but it is a good rule to keep patients in whom a fractured skull has been demonstrated or those who have suffered a period of unconsciousness at absolute bed rest for a minimum

period of three weeks. Not all of this time is necessarily spent in the hospital.

Recently there have been reports from various physicians who have returned from service in the armed forces to the effect that the sooner a patient who has suffered a craniocerebral trauma can be gotten out of bed and up and around the less likely he is to develop a postconcussion neurosis. While this view may be true in cases of head injuries received in military service, I cannot subscribe to it on the basis of my experience in civilian neurosurgery.

When expected recovery from a craniocerebral trauma in a reasonable length of time under intelligent management is not realized, it is assumed that the general practitioner, general surgeon or neurologist will seek consultation with a neurologic surgeon. In case the failure to recover is due to a subdural hematoma or hydroma the neurologic surgeon can be a life saver if not a mind saver.

Subdural hematoma is a frequent and far too often unrecognized complication of head injury. The bleeding is usually venous and therefore slow and often intermittent. The time interval between the receipt of the trauma and the onset of symptoms is from a few days to many months. Inasmuch as a subdural hematoma takes a rather flat saucer shape its pressure over any particular area of the brain is frequently insufficient to cause objective neurologic signs of lateralizing or localizing value. Instead, mental hebetude, changes in personality and intractable headache with frequent blurring of vision are the most common symptoms. Not few patients are confined within the walls of mental hospitals with psychiatric diagnoses who in reality have subdural hematomas, nor is the trauma which is capable of producing subdural hemorrhage always a direct blow to the head. A man firing a shotgun may bleed subdurally from the violent throwing back of the head when the gun recoils. In elderly patients the most trivial and therefore easily forgotten trauma is capable of producing this serious complication. A

careful neurologic examination may lateralize the lesion, but often it is bilateral and one must resort to encephalography or exploratory trephination. The prognosis of this condition depends, of course, upon the size and locality of the clot and the time interval before its recognition and subsequent drainage. As a general rule the prognosis is good providing the preceding cerebral edema and laceration have not irrevocably damaged the brain. The treatment is surgical drainage which rarely requires more than a trephine opening drilled up to a number four bit. As soon as the dura, which is dusky blue in color and many times its normal thickness, is incised the liquid portion of the clot will not infrequently spurt out a few feet. The clotted portion is washed out with warm saline solution. It is not necessary to remove the capsule enveloping the clot. The results following drainage are often dramatic and many times it has been my experience to have the patient recover consciousness while still on the operating table when local anesthesia only has been used. It is best to drain subdural hematomas for at least forty-eight hours, forcing fluids in the meantime.

Subdural hydromas or hygromas, which are lakes of cerebrospinal fluid encapsulated in the subdural space, said to be formed by a small rent in the arachnoid membrane allowing escape of fluid into the subdural space but not its return to the subarachnoid space, present, in general, the same symptomatology as their cousin subdural hematomas but fortunately are far less frequent since, in general, the prognosis following surgical drainage of these lesions, which for some reason is not clear, is far less favorable.

An epidural or extradural hemorrhage, unlike a subdural hemorrhage, is produced by arterial bleeding, most frequently from the posterior branch of the middle meningeal artery. Linear fractures of the squamous temporal bone are prone to be followed by this most fatal complication. The epidural hemorrhage, again differing from

the subdural hemorrhage, takes a distinctly globular form so that localizing neurologic objective signs develop rapidly. The time interval between the receipt of injury and the onset of symptoms is much shorter and usually is only a matter of an hour or two. The injury usually, but not always, is followed by a momentary period of unconsciousness, to be followed by a lucid interval, which in turn is followed by increasing drowsiness, severe headache, vomiting and ultimately unconsciousness. As a rule lateralizing signs develop quickly. A fixed dilated pupil and a contralateral Babinski will indicate the side on which bleeding is in progress. The spinal fluid is usually clear and under greatly increased pressure. Prompt surgery must follow if the patient's life is to be saved. In most cases if more than six hours elapse between the onset of symptoms and surgical intervention, the mortality rate is 100 per cent and even with prompt operative interference the death rate is better than 30 per cent. It is necessary to perform a generous subtemporal decompression in these cases inasmuch as it is imperative that the bleeding point be found and stopped, either by compression, coagulation, silver-clipping or suturing a piece of macerated muscle over it or by a combination of all these measures. The prognosis, in the event the patient survives, is usually excellent inasmuch as the pressure of the hematoma while sudden and considerable is too evanescent to be followed by irrevocable cerebral damage.

Meningitis is an occasional complication of a compound skull fracture of the cranial vault or a basilar fracture accompanied by otorrhea or rhinorrhea. Any one or several of the common pyogenic cocci are the usual invading organisms. A marked hyperthermia, accompanied by cervical rigidity and a positive Kernig sign should make one extremely suspicious of meningitis, but it must be remembered that a considerable amount of bleeding into the subarachnoid space will also produce these phenomena. Withdrawing a specimen of spinal fluid for a cell count, smear and culture will clinch

the diagnosis. When the diagnosis has been established or strongly suspected, massive doses of the sulfa drugs must be administered, such as 5 Gm. of sodium sulfadiazine in 500 cc. of normal saline solution intravenously, to be repeated every eight hours. This mode of administration can then be supplemented or entirely replaced by the oral administration if the drug can be tolerated by that route. One should strive to maintain a blood-sulfa level of 18 or better until the spinal fluid cell count is normal or the culture negative. We have been less impressed with the efficacy of penicillin in the pyogenic meningitides, but the latter may be given in doses of 30,000 units intramuscularly every three hours, or as a continuous intramuscular drip of 120,000 units in 500 or 1,000 cc. of saline solution over a twelve-hour period. In very serious cases one may tap the cisterna magna of 20 to 30 cc. of cerebrospinal fluid and inject 15,000 units in 10 cc. of normal saline solution. In these cases one must avoid overhydration of the brain and keep the total fluid intake at or under 2,500 cc. per twenty-four hours.

Osteomyelitis, epidural abscess and brain abscess are rare complications of cranial trauma, being more often preceded by suppurative sinusitis or otitis media. The first of these conditions may be recognized by local redness, tenderness and tumefaction plus x-ray examination while the latter two are characterized by increasing headache, mental hebetude, fever, leukocytosis, elevated spinal fluid pressure and possible localizing neurologic signs. Their ultimate detection and treatment taxes the skill of the most discriminating neurologic surgeon.

The most common sequela of cranio-cerebral trauma is referred to as the post-concussion syndrome. It is usually characterized by a trinity of subjective symptoms which are headache, dizziness, noticed especially on sudden changes of position, and emotional instability. Memory loss and poor power of concentration are not infrequent complaints. The objective neurologic

examination is in most instances negative in detail, and it is this fact that makes it most difficult to prove its existence when testifying in compensation and civil court. Unscrupulous attorneys are well acquainted with this syndrome and will often coach their clients in its symptoms so that many a jury has been sold a bill of goods on an out-and-out malingerer. The infrequency of this complication developing in children would seem to favor the view that there is an underlying functional as well as organic factor present in the syndrome. The only objective sign of any frequency is nystagmus. The occurrence of the syndrome seems to have no relationship whatever to the severity of the preceding trauma, and I have observed it following such minor blows to the cranial vault as the falling of a venetian blind, following which the patient was not even stunned, much less unconscious. It may make its appearance weeks or months after the trauma. The histopathologic changes underlying the condition are poorly understood. Penfield ascribed the condition to the development of subdural adhesions. Malone recently has brought forth convincing evidence that the syndrome arises from an alteration of vasomotor tonus of the meningeal vessels. The affection is most frequently acquired by emotionally unstable individuals who have been improperly treated from the start. The observance of an adequate period of absolute bed rest and adherence to a strict dehydration regimen are the best assurances against the subsequent development of this troublesome and economically disastrous syndrome. Inasmuch as the symptoms are intensified by overhydration, one may start treatment by moderate fluid restriction, omission of salt in the diet, small doses of sedative drugs, limitation of physical and mental activity and reassurance. If after a few weeks the symptoms still persist, one may give 1 cc. of a solution of 1:2,000 prostigmine methylsulfate intramuscularly twice weekly, and one 15 mg. tablet of prostigmine bromide three times

daily for several weeks. I have observed some very dramatic cures of the syndrome following this treatment. If symptoms still persist after a fair trial of prostigmine, a therapeutic encephalogram is justified. This procedure has the double purpose of severing subarachnoid adhesions and occasionally demonstrating the existence of an unsuspected subdural hematoma or hydroma which could cause the persistence of symptoms. I have repeatedly had the experience of encountering a sudden gush of blood-tinged or xanthochromic spinal fluid while performing an encephalogram when the previous 70 to 100 cc. were crystal clear. This is evidence that subarachnoid adhesions producing a loculation of fluid exerting localized meningeal pressure and irritation have been broken up, thus draining the hydroma. Therapeutic encephalography will usually relieve about 80 per cent of the cases of postconcussion syndrome which have been refractory to other methods of therapy. Occasionally, therapeutic encephalography must be repeated in order to effect a complete and lasting cure. Rarely a severe secondary or even primary anemia following head trauma will mask itself as a postconcussion syndrome. A red count and hemoglobin determination should be done on all patients complaining of chronic headache.

Cases of severe concussion are not infrequently followed by cerebral atrophy, either of the cortex, the white matter or of both. These conditions are well demonstrated by encephalography. Cortical atrophy is characterized by widening of the sulci and large collections of air at the frontal or occipital poles while atrophy of the white matter produces symmetrical enlargement of the lateral ventricles and sometimes even of the third ventricle as well. The dilatation is never as extensive as is found in cases of obstructive hydrocephalus. Mental deterioration may follow cortical atrophy, especially when it involves the frontal poles. Administration of saturated solution of potassium iodide, minims x three times daily, has appeared



to help some of these patients but I do not place much faith in it.

One of the most distressing sequelae of craniocerebral trauma is post-traumatic epilepsy. This condition may develop several months or years after receipt of the trauma, and the convulsion may be localized or generalized, with or without accompanying unconsciousness. The cause of the spells is due to a cortical scar which pulling on the vaso-astral framework acts as an irritative focus and spreads the epileptic impulse. The scar is comprised principally of astrocytes (the principal supporting cell of nervous tissue) and therefore is relatively tough and may pull an adjacent ventricle toward it by contraction. This phenomenon likewise can be demonstrated by encephalography. Occasionally, local excision of a cortical scar is followed by a decrease in the number, severity and duration of convulsive seizures. Of course, surgical excision of a scar is followed by another scar but this scar is made up primarily of oligodendrocytes, instead of astrocytes, and therefore is softer and less liable to distort the vaso-astral framework and give rise to an epileptic impulse. It is this fact, demonstrated by Penfield, which led him and his co-workers to advise local excision of cortical scars after electrical stimulation of the scarred area produced convulsive movements which resembled the original seizures. Their results, while by no means universally successful, have been sufficiently encouraging to warrant a trial of this method when more conservative measures have

failed. Therapeutic encephalography again may be of great value in this condition by separating arachnoidal adhesions overlying the cortical scar. If this fails, recourse may be had to the usual anticonvulsant drugs, such as dilantin sodium, with or without phenobarbital, or phenobarbital and manganese dioxide. The electroencephalogram has proven invaluable in differentiating between essential convulsive disease (or genetic epilepsy) and traumatic epilepsy. It has been our custom to submit all patients with convulsive disease to electroencephalography and if the latter tracing shows a focalizing or lateralizing area we then submit the patient to air-encephalography. If no focus is demonstrated, we then send the patient back to the referring physician for anticonvulsant drug therapy.

In this paper I have made no pretense of thoroughly covering all aspects of craniocerebral trauma. It has been written primarily for the physician or surgeon who is not himself a neurologist or neurologic surgeon. It is sincerely hoped that it will counteract the "therapeutic nihilism" which was in vogue a decade ago in regard to craniocerebral trauma when a popular slogan for a patient suffering from a head injury was: "Put him to bed in a dark room and leave him alone." Under this indolent and pernicious regimen the mortality rate of patients suffering from cerebral injury often rose to 40 per cent or higher. With the management as outlined in this paper, the mortality rate should vary between 18 and 21 per cent. This is a goal well worth working for.





# ACUTE INTUSSUSCEPTION IN INFANCY AND CHILDHOOD\*

CHARLES W. McLAUGHLIN, JR., M.D.

*Omaha, Nebraska*

ACUTE intussusception is the most frequent cause of intestinal obstruction in infancy and childhood and second only to appendicitis as the cause of the acute surgical condition of the abdomen in the same age group. The obstruction produced is invariably of the strangulation type if persistent for any period of time and has carried a distressing mortality through the years.

During an eleven-year period (1936 to 1947) pediatric admissions to the University Hospital and the Nebraska Methodist Hospital were reviewed to note the incidence of intussusception in this area. In 12,288 infant and child admissions from all causes to both institutions twenty patients with intussusception were found, an incidence of .16 per cent. On the University Hospital service, which is an entirely charitable institution, there were seven cases in 3,929 admissions, an incidence of .17 per cent. In the 8,359 private admissions to the Nebraska Methodist Hospital there were thirteen cases giving an incidence of .157 per cent. These figures are of interest since they indicate that numerically intussusception is not common and no single individual in this area of the country will personally see any sizable series of patients. This is undoubtedly a factor of importance when a diagnosis must be made in an atypical case.

Intussusception is apparently seen with a much greater frequency of occurrence in other sections of the world, namely, in Britain and Australia. In this country Ladd and Gross<sup>1</sup> in Boston report their incidence as .3 per cent in 121,515 children's admissions while Gordon<sup>2</sup> in New Haven noted an incidence of .032 per cent

in 133,326 general admissions of all ages. All authors agree that patients are seen with equal frequency on private and charity services.

In Table I representative series of cases published from 1907 to the present have been tabulated. Boys are affected more often than girls in the approximate ratio of 65:35. Intussusception is essentially a disease of the first two years of life, the vast majority of the patients being seen between six to eighteen months of age. (Table II.)

A number of etiologic factors have been observed and suggested for intussusception. These include Meckel's diverticula, polyps or new growths which are said to occur in from 4 to 8 per cent of recorded cases.<sup>15,16</sup> In addition to these factors, inflamed lymph tissue acting as a polyp,<sup>9</sup> defects in the structural arrangement of the splanchnic nervous system and irregular action of the intestinal musculature with spasm of the circular coat have all been suggested as possible causes.<sup>4,17</sup> Attention has been called by Power to the disproportionate growth of the colon and ileum in infancy, both being approximately the same size at birth.<sup>18</sup> Meckel's diverticula were present in two of our twenty cases, an incidence of 15 per cent. It must be accepted today that in the absence of some specific lesion, such as a polyp or diverticulum, the etiology is unknown.

For practical purposes intussusception is seen in three main forms: enteric, colic and enterocolic. From a pathologic standpoint they may be further classified. (Table III.)

True colic intussusception is rare in

\* From the Department of Surgery, University Hospital, University of Nebraska College of Medicine and the Nebraska Methodist Hospital, Omaha, Nebr.

infancy and childhood, being encountered principally in elderly individuals with polypoid lesions of the colon. Enteric or ileo-ileal lesions are seen more frequently and present distinct problems. This type of intussusception tends to begin and

intussusceptum is pushed further and further along the colon until it may become palpable by rectum or protrude through the anus. Ladd and Gross<sup>1</sup> were able to feel the intussusceptum in 29 per cent of their series of patients upon rectal

TABLE I  
COLLECTED SERIES OF INTUSSUSCEPTION IN INFANCY AND CHILDHOOD

Author	Year	Cases	Male %	Female %	Specific Cause Found	Bloody Stools %	Palpable Mass %	Treatment				Deaths	Per Cent Mortality
								Enemas	Reduction	Re-section	Other Procedures		
Hess.....	1905	1,020 collected	...	..	..	...	..	151	549	109	211	513	50.2
Clubbe.....	1907	114	...	...	..	94	..	138	124	8	...	40	33.2
Romanis.....	1918	374	...	...	10	...	..	...	331	30	13	121	32.3
Lanman.....	1921	72	...	...	..	...	..	...	72	...	...	30	41
Perrin and Lindsay.....	1922	400	64	36	..	...	..	...	327	31	42	139	34.7
Harper.....	1922	112	63	37	..	...	..	...	112	...	...	44	39.2
Wade.....	1924	519	397	147	..	...	..	...	...	...	...	73	14.06
Miller.....	1933	20	...	...	2	100	..	...	18	2	...	9	45
Ladd and Gross	1934	372	61	39	..	...	84	...	308	30	...	...	59 (1st 5 yr.) 27 (1st 20 yr.) 14 (last 5 yr.)
Barrington-Ward.....	1936	88	65	35	..	84	..	...	...	...	...	...	20.4
Gordon.....	1940	43	...	...	3	90	77	...	44	...	...	10	23
Kahle.....	1941	151	...	...	15	..	..	...	116	27	8	...	52 30.5 (1st 10 yr.)
Mayo and Woodruff.....	1941	55	...	...	..	...	..	...	44	5	6	13	23.6
Gibbs and Sutton.....	1943	92	62	38	..	71	64	...	77	7	8	28	30.4
McLaughlin...	1947	20	57	43	3	86	76	...	15	1	1	5	23.8

progress slowly, producing mild symptoms at first which are not typical of the ileocolic lesion. Perrin and Lindsay<sup>7</sup> noted a palpable abdominal mass in only eight of their twenty-seven enteric cases, which on the average came late to surgery with a mortality of 55 per cent for the group. They conclude that the type of intussusception with the milder symptoms is ultimately the most fatal. In our own small series of twenty cases three were of the enteric type and in each it was possible to palpate an abdominal mass. Two of these three patients survived, one necessitating a resection.

The enterocolic form of intussusception is the most common one encountered, beginning in the distal 10 to 15 cm. of the ileum and proceeding to the distal portion of the colon. In an effort to expel the abnormal bolus within the bowel the

examination and in four patients it had prolapsed through the anus on admission. Gibbs and Sutton<sup>14</sup> record rectal examinations in sixty-eight of their ninety-two patients, the intussusceptum being palpable in 41.2 per cent of those examined.

The classical symptom complex produced by a typical ileocolic intussusception is well appreciated today. Diagnosis is not difficult in the usual case with dramatic onset, recurrent paroxysms of pain with intervening periods of comfort, development of an abdominal mass and the passage of blood with mucous per bowel. It is the atypical case that offers the more difficult problems in these young patients and the two conditions most likely to be confused are appendicitis and acute enterocolitis.

In general, appendicitis is uncommon under the age of two. Its onset is neither so

sudden nor as dramatic and vomiting with associated abdominal tenderness, muscle guard and distention are more apt to be presenting symptoms.

Acute enterocolitis may be extremely difficult to differentiate and in the absence

exist use of a diagnostic barium enema is certainly indicated. Williams<sup>19</sup> has recently urged a wider employment of this procedure in all questionable cases, both for purposes of diagnosis and as a therapeutic aid prior to surgical reduction.

Aside from volvulus the only other conditions likely to be confused with intussusception are rectal prolapse and abdominal purpura. The first is readily differentiated by a rectal examination while the second may be identified by the finding of petechiae on the body, a tourniquet test and blood studies.

It is generally conceded that surgical reduction is the proper method of treatment for intussusception as soon as the diagnosis is clinically established. Throughout the years there have been those who favored the use of enemas as an alternative to surgery, but the inherent risk of incomplete reduction has gradually placed the treatment of these small patients in the hands of the surgeon. It cannot be said that an enema given before surgery is without value for it often may greatly reduce the manipulation required by the surgeon when open reduction is undertaken. The risk lies in postponing surgery with the belief that the intussusception has been relieved when in reality the small initial intussusceptum has remained unreduced.

Surgical technic in the usual case has become quite standardized.<sup>21</sup> A right rectus muscle splitting or paramedian incision of sufficient length to permit the introduction of a hand is made and the advancing head of the intussusceptum in its ensheathing bowel is located within the abdomen. The intussusception is then reduced within the abdomen, using the two index fingers until only the original portion remains unreduced. Then this is usually delivered outside the abdomen for the final reduction under direct vision. In the usual ileocolic type one rarely encounters great difficulty in the preliminary reduction. We have on occasion experienced some difficulty in negotiating the splenic flexure of the

TABLE II  
OCCURRENCE OF INTUSSUSCEPTION ACCORDING TO AGE GROUP

Author	Cases	Under 1 Yr. %	Under 2 Yr. %	Young-est	Old-est
Perrin and Lindsay...	400	69	78		
Ladd and Gross.....	372	70	87	17 days	11 yr.
Kahle.....	151	50	59		
Gibbs and Sutton....	92	61.5	..	2 mo.	15 yr.
Mayo and Woodruff..	55	65	80		
Gordon.....	43	....	83		
McLaughlin	20	75	95	4 mo.	5 yr.

TABLE III  
TYPES OF INTUSSUSCEPTION ACCORDING TO PATHIOLOGY

Type	Author		
	Ladd and Gross 372 Cases %	Rohan %	Mc- Laughlin 20 Cases %
Enteric.....	7	10-15	20
Colic.....	2	5-10	0
Enterocolic.....	75	75-80	75
ileo-ileocolic.....	9		
ileo-ecocolic.....			
Multiple.....	.8	.....	5
Retrograde.....	.3		

of an abdominal mass the picture is even more complex. One such infant, six months of age, was admitted to the pediatric service at the University Hospital with bloody diarrhea and insignificant abdominal findings. It succumbed a few hours after admission, the clinical diagnosis being acute fulminating enterocolitis. At postmortem examination a gangrenous ileocolic intussusception was found. In such instances in which any question may

colon in some of these infants. The final reduction at the cecum may be extremely difficult due to marked edema of the bowel. Ladd's<sup>15</sup> suggested maneuver that the bowel be wrapped in moist towels and submitted to gentle pressure for a period of several minutes is one of real practical merit. In the last ninety patients coming to surgery Ladd and Gross<sup>1</sup> found it necessary to resect only twice and they attribute this remarkably low incidence to (1) earlier diagnosis; (2) more boldness in completing reductions on patients that previously would have been considered irreducible and (3) better appreciation of the viability of contused, hemorrhagic and edematous bowel after reduction.

In our series of twenty cases two were found at operation to have undergone spontaneous reduction, their being a hemorrhagic terminal ileum and cecum as evidence of the previously existing lesion. Ladd and Gross<sup>1</sup> report sixteen such instances in their series of 373 cases.

Most surgeons today are not impressed with the various procedures of bowel fixation devised to prevent a recurrence of an intussusception and these are not commonly employed. The same may be said for the performance of an appendectomy even though this structure may appear quite edematous and hemorrhagic. Goldman and Elman,<sup>22</sup> however, have recently reported five cases of acute recurrent intussusception occurring in older children in whom spontaneous reduction had occurred after one or several acute attacks. They collected thirty similar cases from the literature and recommend appendectomy to produce adhesions and prevent recurrences if such a case be explored.

When an irreducible intussusception is encountered, one is confronted with a much more serious technical problem. The patient will usually be found to be present with an enteric intussusception, an ileocecal or ileocolic invagination, coming very late to surgery, or one of the multiple types with associated enteric and ileocolic

lesions. When confronted with such a problem, four types of operative procedures have been employed with sufficient frequency to draw some conclusions. These are: (1) resection with immediate anastomosis, either end-to-end or side-to-side; (2) exteriorization or some modification of the Mikulicz procedure; (3) lateral anastomosis about the intussusception; (4) Maunsell's operation; (Jessett-Barker) resection of the intussuscepted mass through a longitudinal incision in the outer sheath of the intussusception followed by closure of this incision and tacking the junction of the entering bowel and the neck of the intussusception.

In Table IV a compiled series of 200 cases of irreducible intussusception are tabulated. These cases reported from 1907 to the present time indicate that intussusception is found to be surgically irreducible in approximately 12.4 per cent of the reported cases.

Resection with immediate anastomosis was first successfully performed for irreducible intussusception in an eleven month old infant in 1907.<sup>4</sup> In the same year Collinson<sup>23</sup> successfully resected the terminal ileum and ascending colon in a three month old infant using a Mayo-Robson button at the line of anastomosis. Since 1907 reports of ninety-nine resections have been collected with an overall mortality of 67.8 per cent. It is interesting to note that the mortality following resection has dropped from 84 per cent (thirty-two cases) in the period from 1907 to 1917 to thirty-nine per cent (forty-eight cases) in the decade from 1937 to 1947.

Resection of the gangrenous lesion by a modified Mikulicz procedure has been the second most commonly employed procedure. Its principal and obvious disadvantage is the resultant ileostomy which is poorly tolerated even for short periods of time in infancy. Ladd and Gross<sup>1</sup> report only one recovery in fourteen patients when using this technic while Gibbs and Sutton<sup>14</sup> had no recoveries in seven patients treated by this method. Hindmarsh et al.<sup>41</sup>

TABLE IV  
COMPILED SERIES OF IRREDUCIBLE INTUSSUSCEPTIONS. SURGICAL PROCEDURE

Author	Year	Total Cases	No. Irreducible	Resection and Anastomosis				Maunsell's Procedure			Lat-eral Cases	Anastomosis		Colostomy or Mikulicz's Procedure			Mortality in Irreducible Cases Per Cent
				Per Cent	Cases	Deaths	Per Cent	Cases	Deaths	Per Cent		Deaths	Per Cent	Cases	Deaths	Per Cent	
Clubbe.....	1907	127	8	6.3	8	7	87	..	..	..	..	..	..	..	..	..	87
Collinson.....	1907	...	1	...	1	0	0	..	..	..	..	..	..	..	..	..	0
Coffey.....	1907	...	1	...	1	0	0	..	..	..	..	..	..	..	..	..	0
Rutherford.....	1909	...	7	...	3	3	100	2	2	100	2	1	50	..	0	..	86
Parry.....	1909	...	1	...	...	..	...	..	..	..	1	0	0	..	..	..	0
Dowd.....	1912	...	1	...	1	0	0	..	..	..	..	..	..	..	..	..	0
Eccles and Laidlow.....	1912	89	9	10	9	9	100	..	..	..	..	..	..	..	..	..	100
Koch and Oerum.....	1912	400	8(?)	...	8	8	100	..	..	..	..	..	..	..	..	..	100
Eisendrath.....	1915	...	1	...	1	0	0	..	..	..	..	..	..	..	..	..	0
Southern and Cranshaw.....	1921	...	2	...	2	0	0	(one resection done below anus)				..	..	..	..	..	0
Perrin and Lindsay.....	1922	400	53	13	47	38	79	..	..	..	..	..	..	6	6	100	83
Montgomery and Musil.....	1930	...	2	...	...	..	...	..	..	..	2	0	0	..	..	..	0
Ladd and Gross.....	1934	372	33	9	16	15	93	3	3	100	..	..	..	14	13	93	94
Elliott-Smith.....	1935	...	4	...	1	0	0	..	..	..	3	0	0	..	..	..	0
Stuppel.....	1939	...	1	...	...	..	...	..	..	..	1	0	0	(Subsequent Resection)			0
Greenberg.....	1939	...	1	...	1	0	0	..	..	..	..	..	..	..	..	..	0
Forty.....	1940	...	1	...	1	0	0	..	..	..	..	..	..	..	..	..	0
Mayo and Woodruff.....	1941	55	8	14.2	5	2	40	..	..	..	3	0	0	..	..	..	25
Laycock.....	1941	...	1	...	1	0	0	..	..	..	..	..	..	..	..	..	0
Kahle.....	1941	151	33	22	27	13	48	2	2	100	2	2	100	2	1	50	54.5
Vellaocot.....	1942	...	1	...	1	0	0	..	..	..	..	..	..	..	..	..	0
Gibbs and Sutton.....	1943	92	15	16.3	7	3	42	..	..	..	1	1	100	7	7	100	73.3
Capone.....	1944	4	1	25	1	1	100	..	..	..	..	..	..	..	..	..	100
Clark.....	1944	...	1	...	1	0	0	..	..	..	..	..	..	..	..	..	0
Fallis and Warren.....	1945	...	2	...	2	0	0	..	..	..	..	..	..	2	0	..	0
Hindmarsh et al.....	1945	...	2	...	...	..	...	..	..	..	..	..	..	1	1	100	50
McLaughlin.....	1947	...	2	...	1	0	0	..	..	..	..	..	..	..	..	..	..
		200			146	99	67.8	7	7	100	15	4	26.6	32	28	87.5	Av. 69

in 1945 reported two successful procedures of this type in children, catheters being placed in each loop at operation. In both cases the spur was crushed six days after resection and the stoma successfully closed on the twelfth day after the original operation. The overall mortality with this technic in thirty-two collected cases has been 87.5 per cent and during the past decade it has remained at 73 per cent.

Rutherford<sup>25</sup> and Parry<sup>26</sup> independently reported the successful management of irreducible intussusceptions by lateral anastomosis in 1909. Subsequent favorable reports have been published by Montgomery and Mussil,<sup>32</sup> Mayo and Woodruff<sup>13</sup> and Elliott-Smith.<sup>33</sup> Parry<sup>26</sup> strongly recommended this procedure for its simplicity, because it provides an alternative line of treatment to prolonged manipulation in irreducible cases and last since the palpable mass tends to disappear in from one to three weeks following lateral anastomosis. This method can only be considered in irreducible cases of the ileocolic type since the sheath in such a lesion usually remains viable. Elliott-Smith<sup>33</sup> records the successful employment of lateral anastomosis in an enteric intussusception, but its use in such a case is hazardous as evidenced by Stuppel's<sup>34</sup> experience. He performed an anastomosis around an enteric intussusception in which the sheath seemed entirely viable. Pain continued with the development of localizing peritoneal signs. Upon reoperation the entire intussusception was found to be gangrenous and was resected with a successful result. Reports of fifteen cases handled by this method have been collected from the literature with an overall mortality of 26.6 per cent. During the past decade seven patients treated by this technic have resulted in a mortality of 43 per cent.

The procedure known under the name of Jessett, Barker or Maunsell has been infrequently employed during the past forty years in the management of these

irreducible cases. A very similar, but somewhat more radical procedure, was described by Coffey<sup>24</sup> with its successful employment in one child of seven years. Except for this one reported case, the remaining seven collected patients subjected to this type of procedure all died.

In our series of twenty cases two were found to be irreducible at operation. In one of these an exteriorization procedure was carried out, the infant succumbing with shock three hours after surgery. The second infant, eight months of age with a double enteric and associated ileocolic lesion, was successfully resected with immediate lateral anastomosis.

Since intussusception is essentially a problem affecting infants in the first year of life, it is to be expected that the mortality in all cases, and particularly the irreducible ones, will be highest during this period. Koch and Oerum<sup>29</sup> found only six successful resections for irreducible intussusception in those under one year of age in 1912. Perrin and Lindsay<sup>7</sup> in 1922 reported no survivals in forty-seven children under three years of age who submitted to resection. In 1941 Kahle<sup>12</sup> reported that while his overall mortality was 52 per cent in a series of 150 cases the mortality was 57 per cent in the infant group seen during the first twenty-four hours, 85.7 per cent in the group seen at the end of twenty-four hours and 100 per cent in the group coming for treatment after this period of time.

During recent years the general picture has improved and increasing numbers of successful surgical procedures in irreducible cases are being reported. From a technical standpoint this improvement is probably due to improved anesthesia, greater appreciation of the importance of maintaining these small patients' body heat and expediting the operative procedure.

#### SUMMARY AND CONCLUSIONS

1. Intussusception is the second most frequent cause of the acute surgical condition of the abdomen in infancy and child-

hood and the most common cause of acute intestinal obstruction in this age group.

2. While the overall mortality has shown a progressive improvement during the past forty years, it is still distressingly high.

3. Intussusception has been found to be irreducible in approximately 12.4 per cent of the published series.

4. The various surgical procedures for the management of irreducible intussusception have been outlined, with the reported mortality figures.

5. Resection with immediate anastomosis is the most practical method of handling the irreducible case and has resulted in a steady drop in mortality rates in recent years.

6. It is suggested that a decision as to necessity of resection be made as promptly as possible after reasonable manipulation has been carried out to limit the operative time and to reduce the lethal factors of postoperative shock and toxemia.

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# DUO LIQUID ADHESIVE

## ITS USES IN NEUROSURGERY

RALPH B. CLOWARD, M.D.

*Honolulu, Hawaii*

IT has always been the practice of neurosurgeons to shave the entire head in preparation for cranial operations. The only exception to this practice found in the literature is suboccipital craniotomy. In some of Dr. Cushing's illustrations the occipital region only was shaved in cerebellar cases and the long hair on the front of the head was left in braids. But he consented to save the patient's hair only in very special cases. Dr. Percival Bailey has said many times, "I would never attempt any operation on the head without a complete preparation. The risk of infection is too great. I do not like hair in the field of operation." These sentiments are quite universal among neurosurgeons.

Every neurosurgeon has had the experience of hearing bitter complaints from their female patients who had been told their heads must be shaved for operation. Women patients have even refused to be operated upon if their heads had to be shaved. They would "rather die (from their brain tumor, of course) than lose their hair." When a woman is that vain, one begins to look around for a method whereby the operation can be done without completely removing the hair.

In 1938 Duo Liquid Adhesive was obtained from the company\* who advocated its use in the application of small dressings to wounds of the scalp and face. For this use it was found far superior to adhesive tape and every other adhesive substance which the writer had used to make dressings adhere to the scalp and face. The idea was conceived of using liquid adhesive to seal off the hair for cranial operation when the patients did not wish to have their

entire head shaved. The product was used successfully in this manner for three years. The purpose of this communication is to describe the method of its use in surgery and to acquaint neurosurgeons with a valuable product.

Duo Liquid Adhesive can be used to seal off the hair for any operation upon the head or face. It is most useful, however, in (1) suboccipital operations, either midline cerebellar exposures or unilateral incisions for fifth and eighth nerve sections, etc.; (2) frontal flaps, unilateral or bilateral where the concealed incision is made just behind the hairline; (3) ventriculogram and other exploratory trephine operations; (4) prefrontal lobotomies.

### METHOD

The scalp is shaved over the area which is to be exposed for surgery. (Fig. 1a.) The hair need be removed only about 1 cm. or so beyond the line of the scalp incision. The liquid adhesive is supplied in a tube and has the appearance and consistency of tooth paste. It is applied about the shaved area, half in the hair and half on the bare scalp. (Fig. 1b.) Four to six thicknesses of gauze cut large enough to cover the entire head and hair are placed over the head and the soft paste worked through the gauze by gentle pressure with a blunt object. (Fig. 1c.) Only two to three minutes are necessary for the adhesive paste to dry and the gauze to become firmly adherent to the scalp and hair. With a sharp scissors the gauze over the operative area is cut off. (Fig. 1d.) The exposed area of scalp can now be scrubbed for sterile preparation with soap and water, iodine, alcohol or any other liquid (except ether) without fear of dislodging the dressing.

\* Duo Liquid Adhesive was obtained from The Johnson & Johnson Co., New Brunswick, N. J.



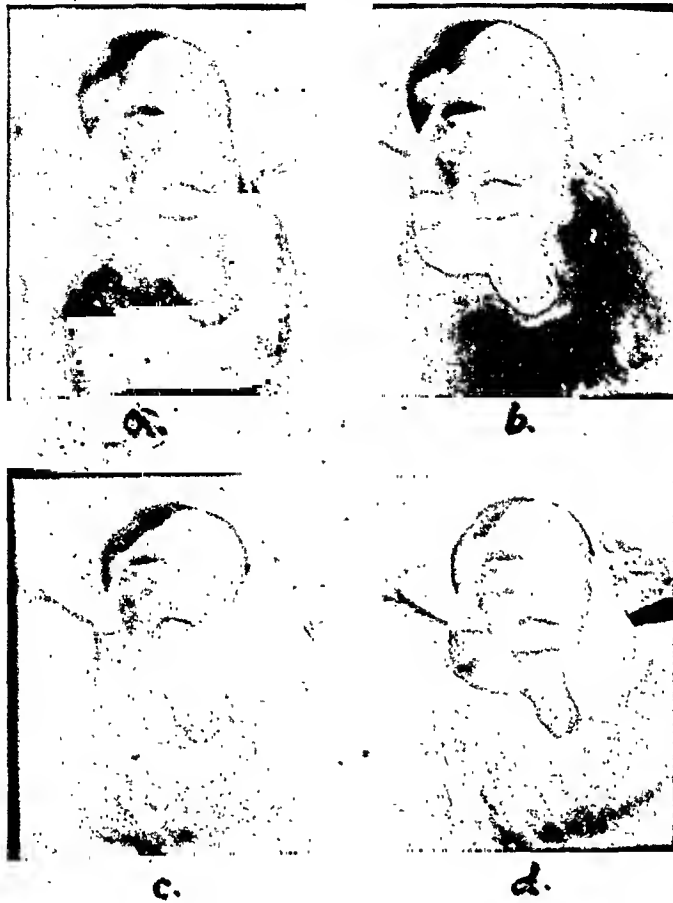


FIG. 1. Method of sealing the hair in preparation for ventriculogram. *a*, small area shaved. *b*, liquid adhesive applied half on the hair and half on the scalp. *c*, head covered with gauze and adhesive paste worked through it. *d*, gauze cut exposing operative field.

The liquid adhesive is a rubberized compound and aqueous or alcoholic solutions do not interfere with its adhesive property. The skin incision is then scratched  $1\frac{1}{2}$  cm. (or more) inside the gauze edge, draped with sterile wet towels and secured to the scalp with sutures or small towel clips. The towels are then raised and a thin rubber sheet is slipped between them and the gauze. The patient's head and hair as well as the gauze covering it are thus kept clean, dry and free from blood stains.

At the end of the operation the large gauze dressing covering the hair is not removed but left adherent to the scalp. Sterile dressings are placed over the wound and the entire head bandaged. On the second or third postoperative day, when

the skin sutures are removed, the large gauze square may be taken off and the wound covered with a liquid adhesive dressing. The gauze may be left in place until the wound is completely healed. Upon removing the dressing one will find that all of the liquid adhesive adheres to the gauze and comes off with it. None is left on the skin or hair to be cleaned off with ether and benzene as is necessary with other adhesive products.

#### CONCLUSIONS

1. Duo Liquid Adhesive has been used in cranial surgery to seal off the hair from the operative field and thus obviate the necessity of shaving the entire head.
2. The method of its use is described.

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# Case Reports

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## SOLITARY CALCIFIED CYST OF THE SPLEEN\*

JOSEPH A. WITTER, M.D. AND VIOLA G. BREKKE, M.D.

*Highland Park, Michigan*

CYSTS of the spleen are rarely encountered in surgical practice. According to Gallagher and Mossberger<sup>8</sup> in 1942, 155 cases of non-parasitic cysts of the spleen had been reported. Eight additional cases have been found in available literature since that time.<sup>2,4,9,13,15,16</sup>

There are many classification of cysts of the spleen. The most satisfactory is the classification by McClure and Altemeier<sup>10</sup> which is a modification of those submitted by Moynihan<sup>11</sup> and Fowler.<sup>5</sup> Cysts of the spleen are divided into true and false cysts depending upon the presence or absence of a specific lining membrane. True cysts have three subdivisions: (1) epithelial which may be dermoid or epidermoid; (2) endothelial which include lymphangioma, hemangioma, polycystic disease and some serous cysts; (3) parasitic, lined by a protoplasmic matrix as the echinococcic cysts. The false or pseudocysts have only a hyaline fibrous wall or a condensed rim of splenic tissue. False cysts have four subdivisions: (1) hemorrhagic or (2) serous, depending upon their contents; (3) inflammatory, due to acute necrosis in infections; (4) degenerative, due to liquefaction necrosis in infarcts.

According to Fowler,<sup>6</sup> echinococcic cysts occur about twice as frequently as all the various forms of non-parasitic cysts. The incidence of false cysts is about four times as great as that of true cysts. About 80 per cent of the false cysts are large, solitary and unilocular, about two-thirds being hemorrhagic and the others being serous depending upon the nature of the contents. We

wish to report a case of solitary, calcified, serous pseudocyst of the spleen.

### CASE REPORT

The patient, a forty-eight year old white, unmarried woman, was sent to the hospital February 3, 1946, by Dr. C. J. Barone. She complained of a feeling of fullness in the left upper part of her abdomen aggravated by eating. At times she had dull aching pain in that area and felt that something was pressing upward into her chest.

In 1928, after running down a steep hill, she bumped into the corner of a building and injured her left anterior chest wall and left iliac crest. She heard "gurgling sounds" in that area and later noted some swelling of the upper abdomen. Three ribs on the left side were fractured. The pain gradually subsided. In 1931 she fell forward in a bus and again injured her left chest and upper abdomen. There were no fractures. Since that time she had intermittent dull pain in the upper left abdomen associated with indigestion, flatulence and attacks of vomiting. In 1943 she fell down a short flight of stairs but there was no apparent injury.

Physical examination revealed an obese, well developed, forty-eight year old white woman not appearing ill. The eyes, ears, nose and throat were normal; the lungs were clear; the heart was not enlarged and there were no murmurs. Abdominal examination revealed a heavy panniculus without scars or herniation. Palpation elicited no tenderness and no organs or masses could be felt. No asymmetry was present and there was no bulging in either flank. Blood pressure was 140/90, pulse 78, temperature 98.6°F and respirations 18.

Laboratory data: Urinalysis negative; Kahn negative; the hemoglobin was 80 per cent;

\* From the Departments of Surgery and Pathology, Highland Park General Hospital, Highland Park, Mich.



FIG. 1. Film taken after barium meal showing calcified mass beneath the left diaphragm.  
FIG. 2. Film showing large partially calcified mass in the left quadrant.



FIG. 3. Lateral view of the resected spleen showing bulging of the calcified mass.  
FIG. 4. View of the cut spleen showing the cyst.

the red blood cell count was 4,010,000; the white blood cell count was 5,600 with 76 per cent neutrophils; the platelet count was 770,000. Coagulation time was four and one-half minutes. Bleeding time was two and one-half minutes. Prothrombin time was 67 per cent of normal. Blood non-protein nitrogen was 30 mg. per 100 cc. of blood. The total protein was 8.0 Gm. with serum albumin 4.9 Gm. and serum globulin 3.1 Gm. X-rays of the abdomen revealed a spherical, partially calcified tumor (possibly within the spleen)

in the left upper quadrant just below the diaphragm with a diameter over 4 inches. (Figs. 1 and 2.)

In view of the position of the tumor, history of trauma and the vague, indefinite complaints a tentative diagnosis of splenic cyst was made. On February 8, 1946, under gas ether anesthesia the abdomen was opened through a high, left rectus incision. No free fluid was noted upon opening the peritoneal cavity. There were various adhesions between the diaphragm, stomach and anterior abdominal

wall which were broken by the examining finger. The tumor was found to arise within the spleen and had a dense, calcified wall. The splenic pedicle was quite free and easily clamped and the spleen was removed readily through the wound. (Fig. 3.) The left upper quadrant appeared normal following the splenectomy and there was no bleeding. Examination of the stomach and duodenum revealed no evidence of ulcer. There were some adhesions between the gallbladder and the hepatic flexure of the colon which were readily separated. The pancreas and liver appeared normal. Using interrupted cotton sutures, the abdominal wall was closed in layers without drainage. The patient's immediate postoperative condition was good. One hour later she went into shock. The blood pressure was 80/70 and the pulse imperceptible. She was given supportive treatment and blood transfusions and in a few hours her condition was good. After that she had an uneventful convalescence and was discharged on February 21, 1946.

The pathologic examination was as follows: Grossly, the spleen measured 17 by 10 by 9 cm. At the upper pole, there was a rigid mass which bulged on the diaphragmatic surface of the spleen. In this area the mass was not covered by splenic tissue and was smooth, pale yellow and calcified. The cut section (Fig. 4) revealed a spherical encapsulated cyst filled with thin, reddish-brown fluid glistening with cholesterol crystals. The cyst measured 9 by 8 cm. and its wall varied from 3 to 10 mm. in thickness. The lining was fairly smooth, pale yellow and calcified except for areas of trabeculation between which the rim of splenic tissue was seen.

Microscopically, sections of the spleen revealed the cyst wall to be composed of dense hyalinized connective tissue. (Fig. 5.) There was no epithelial lining and no notable alterations in the pulp, sinusoids or capsule of the spleen.

**Diagnosis:** Solitary calcified cyst of the spleen.

#### COMMENT

This case is fairly typical of splenic cysts in general because of the vague, non-specific complaints of fullness in the upper abdomen and symptoms related to the ingestion of food. The lack of specific com-



FIG. 5. Microphotograph of section through the cyst showing the wall of fibrous tissue. No epithelial lining.

plaints has made this condition undiagnosed preoperatively in many reported cases. Other pathologic entities in the left upper quadrant to be considered are tumors of the stomach, pancreas, liver, omentum, kidney and even ovary. Echinococcal cysts which occur twice as frequently as all various types of non-parasitic cysts must be differentiated. This can usually be detected by the complement fixation, precipitin and cutaneous allergic tests.

X-ray is of considerable value in diagnosis either by direct or indirect evidence. In the case presented the calcified wall of the cyst gave direct evidence of a tumor under the left diaphragm although it could not be palpated on careful physical examination. The similarity to a case described by Shawan<sup>14</sup> gave us an excellent clue as to what to expect in this patient. When there is no calcification of the cyst wall, the x-ray evidence is indirect but may be just as conclusive. Ostro and Makover<sup>12</sup> claim that downward displacement of the splenic flexure of the colon is diagnostic of splenic cyst. Interestingly, ordinary splenomegaly does not displace the left colon. As pointed out by several contributors to the subject, displaced viscera always return to their normal location after splenectomy.

Cysts of the spleen are found more often in women. The spleen is congested in pregnancy, menstruation and the menopause. Splenic cysts may be associated with pregnancy.<sup>1</sup> The cases presented by Frank<sup>7</sup> and by Dobrzaniecki<sup>3</sup> tend to show that splenic cysts are affected by menstruation. Frank found it necessary to marsupialize the splenic cyst and for many months there was bleeding from the sinus tract at each menstrual period. The case reported by Dobrzaniecki had severe dysmenorrhea relieved by splenectomy for the splenic cyst.

Trauma appears to be a factor in pseudocysts of the spleen. According to Fowler<sup>5</sup> history of trauma was obtained in 50 per cent of the hemorrhagic and in 16 per cent of the serous cysts. In the case presented the history reveals several episodes of trauma to the upper abdomen any one of which may have produced an intrasplenic hemorrhage without laceration of the capsule. After absorption of the blood a cyst with serous contents and a fibrous calcified wall resulted.

#### SUMMARY

A case of solitary calcified serous pseudocyst of the spleen is presented.

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# SPONTANEOUS RUPTURE OF THE NORMAL SPLEEN

THEODORE P. SCHOMAKER, M.D.\* AND CLAUDIUS Y. GATES, M.D.\*

*San Francisco, California*

ACCIDENTS involving the spleen are of frequent occurrence. Among these traumatic rupture is most frequent and is often associated with falls from heights and vehicular injuries. Occasionally such injuries give rise to secondary so-called delayed splenic ruptures in which the initial injury is followed by a latent period varying from a matter of hours to days, weeks or even months. Zabinski and Harkins<sup>1</sup> in 1943 collected 177 cases of delayed splenic rupture from the literature. In the majority of cases the delayed rupture occurred before the end of the first week. Instances have recently been reported<sup>2,3</sup> in which latent periods of four and seven months elapsed between the original injury and delayed rupture of the spleen. An aid to diagnosis in such cases is a painstaking history and a cooperative, intelligent patient.

Less common, but occurring with increasing frequency, is the report of rupture of the diseased spleen. Susman<sup>4</sup> mentions spontaneous rupture occurring in spleens associated with malaria, typhoid fever, pregnancy, leukemia, acute infections, typhus fever, relapsing fever, cystic degeneration, malignant growths, hydatid disease, infarction, torsion, abscess and varices.

Spontaneous rupture of the normal spleen is extremely rare. Brines<sup>5</sup> in 1943 was able to collect from the literature thirty-five authentic instances of spontaneous rupture of the normal spleen. His own case brought the total to thirty-six. If instances to which valid objection might be made in this group were deleted, the total is lowered to twenty-four. Brine's survey is not complete, however, since other cases appeared in the literature prior to his article which he failed to cite.<sup>6,7</sup> The

question of whether or not a spleen is normal which ruptures without antecedent trauma or co-existing disease is academic. Again and again reference is made to the contention of Ledderhose and Focault who maintained that spontaneous rupture can occur only in the diseased spleen. Such pathologic conditions which antecede the rupture may be focally localized and the act of rupture is associated with the destruction of the pathologic condition. It must also be borne in mind that spontaneous is perhaps a misnomer since trauma, however minimal, is undoubtedly associated with the rupture. Such trauma might be represented as physiologic and be associated with a sudden increase in intra-abdominal pressure such as that caused by coughing, sneezing, vomiting, lifting, etc.

Clinically, one is confronted with a desperately acute intra-abdominal surgical emergency. Most of these cases are erroneously diagnosed preoperatively as perforated peptic ulcer and less commonly in the female as ruptured ectopic pregnancy. Kehr's sign, that is pain in the left shoulder, is helpful when present and led to the preoperative diagnosis in the second of the two cases herein reported. Zabinski and Harkins<sup>1</sup> found this sign present in nineteen of sixty-eight patients. Because of the tendency to confuse the findings with those found in perforated peptic ulcer, a survey film of the abdomen is usually obtained. It was pointed out in 1944<sup>6</sup> by Levine and Solis-Cohen that in certain instances in such a film the normal splenic shadow is delineated against the outline of the adjacent stomach, especially when the latter is filled with gas. With splenic rupture, blood gravitates along the gastrosplenic ligament and the hematoma produces in-

\* Formerly Lieut. Colonel in the Army.

dentures or serrations along the greater curvature of the stomach. The stomach is also displaced to the right and the colon downward. This observation was recently confirmed by O'Neill and Rousseau.<sup>7</sup> Were such radiologic findings to be constant, the diagnosis would be greatly simplified. In neither of the cases herein reported were such radiologic findings obtained although flat plates of the abdomen were made in both instances.

#### CASE REPORTS

**CASE I.** A soldier, aged thirty-one, was admitted to the hospital on February 11, 1943, at 1:30 A.M. He was perfectly well until five hours earlier, at which time he began to have severe, sharp epigastric pains which remained fairly well localized. While en route to the hospital, he vomited once, the character of which was unknown to him because of darkness. Upon arriving at the hospital, he had what he described as a normal bowel movement. There was no past history of previous epigastric distress or any history suggestive of peptic ulcer. Careful interrogation both preoperatively and postoperatively revealed no history of recent or late trauma, even of minimal degree. The systemic history was not remarkable.

Examination on admission revealed a white male, obviously in distress due to abdominal pain. The temperature was 100°F., pulse, 90; respiration, 20 and blood pressure, 100/80. General physical examination was not remarkable. Abdominal examination revealed a board-like abdomen with generalized tenderness. Rebound tenderness was present throughout. Liver dullness was not obliterated. There was no radiation of the pain to either shoulder. Peristalsis was active. A survey film of the abdomen showed no evidence of air beneath the diaphragm. Red blood cells were 4,800,000; white blood cells, 18,600; polymorphonuclears, 95 per cent; hemoglobin, 13.4 gr.

Celiotomy was performed through a right upper paramedian muscle splitting incision under spinal anesthesia. Before incising the peritoneum one could observe the dark blood beneath it. About 700 cc. of liquid blood and a quantity of large clots were evacuated from the peritoneal cavity immediately after it had been opened. The spleen was found to be the source

of hemorrhage. It was about normal in size and was congenitally fissured with a laceration along the middle fissure. The pedicle was frayed; it was ligated and the spleen removed. During the operative procedure the blood pressure fell to 98/50 and supportive therapy consisting of administration of 1,000 cc. of liquid plasma and 600 cc. of whole blood was instituted. This resulted in a prompt rise in blood pressure. The patient made an uneventful recovery except for atelectasis which developed on the second day. The platelet count gradually rose on the third postoperative day from a base of 241,000 to 1,360,000 on the eleventh postoperative day. From this maximum height it gradually decreased until the time of dismissal on March 11, 1943, at which time the platelet count was 468,000.

Pathologic report revealed the following: The spleen measured 12 by 10 by 4 cm. There was one large fissure that partially bisected the spleen. Two smaller fissures were present at one pole. At the opposite pole there was a hemorrhagic bullous area  $5\frac{1}{2}$  by 4 cm. There was an acutely torn area involving most of the large fissure. The capsule was lifted up by an area of hemorrhage in this region. On section the central portions of the spleen were poorly fixed. The tissue was red, firm and the corpuseles were barely visible. In the hemorrhagic areas, blood penetrated irregularly through the parenchyma. Microscopically, in most regions the spleen was normal. The sinusoids were quite empty. The corpuseles were small and sharply outlined. In the grossly hemorrhagic zone there was considerable distortion of the normal structure by hemorrhage; in other places the blood had diffused through the tissues. The process was acute. There was no significant alteration of the normal structure of the spleen to account for the focal rupture without trauma. Diagnosis: Focal rupture of spleen in normal anatomic fissure; subcapsular bullous hemorrhage and focal interstitial hemorrhages.

**CASE II.** A soldier was admitted to the hospital on June 28, 1945, from another installation with a transfer diagnosis of "Observation for renal colic manifested by pain in the left chest and left upper abdomen." The symptoms began two days prior to admission when he was awakened from sleep at about 2:00 A.M. with severe pain in the upper left quadrant of the abdomen and around the heart which radiated to the left shoulder. He had no

nausea or vomiting at the time. The pain continued and he was admitted to a nearby medical facility thirty hours after the onset of symptoms. While there his pain became worse, and he was observed for another twenty-four-hour period before being transferred.

The past history gave no indication of previous digestive disturbance. He stated that his health was excellent prior to the onset of pain. He had had no discomfort to limit his general activity. Careful questioning revealed no history of injury. In November, 1944, approximately seven months prior to the onset of the present illness, he was subjected to a severe concussion by the explosion of a booby trap near him while on duty near Germany. He received no fragment wounds or injuries other than the concussion, and he was returned to full duty in February, 1945. At the time of admission he complained bitterly of pain in the left epigastrium and pain in the left shoulder. The patient appeared to be quite ill and was lying doubled up on his side, loathe to move. General physical examination was unrevealing. There was no marked pallor of the skin or mucous membrane. Abdominal examination showed a tense, rigid abdomen with extreme tenderness in the left upper quadrant and in the region of the midline. Peristalsis was active. There was rebound tenderness throughout the abdomen. Liver dullness was not obliterated. The temperature was 100°F.; pulse, 120; respirations, 22; blood pressure, 104/70; red blood cells, 4,190,000; hemoglobin, 76 per cent; white blood cells, 24,000; polymorphonuclears, 97 per cent. A flat plate of the abdomen failed to reveal the presence of free air in the abdomen.

A probable diagnosis of perforated peptic ulcer was made with a provisional diagnosis of possible spontaneous rupture of the normal spleen. The patient was taken to surgery and an upper midline incision made. Upon opening the peritoneal cavity a large amount of blood was found. On exploration the source was revealed to be the spleen. To facilitate exposure a transverse incision was made to the left from the mid-portion of the midline incision, cutting across the rectus muscle. The spleen seemed to be enlarged about three to four times its normal size, but upon further inspection this apparent increase in size was due to a massive subcapsular hemorrhage. Fresh bleeding was originating near the hilus. It was estimated that about 1,600 cc. of blood represented by

free blood and clots were found in the abdomen. The patient's postoperative convalescence was uneventful. The platelet count was carefully followed postoperatively. From a normal of 283,500 it never rose higher than 350,000 over the period of observation for the next two months. Upon release from the hospital the blood count was well within normal limits.

The pathologic report revealed the following: The specimen consisted of a spleen measuring  $11\frac{1}{2}$  by  $6\frac{1}{2}$  by 4 cm. It weighed 125 Gm. The capsule over the surface of the spleen was stripped almost entirely except for a triangular surface at the lower pole. The capsule over the anterior inferior surface of the spleen was also stripped from the hilus. At the lower pole of the spleen there was a clot measuring 4 by 2.5 cm. between the capsule and the spleen. Microscopically, in one section there was a large extravasation of blood between the splenic pulp and the capsule. The lymph follicles in the spleen were distinct. The sinusoids were relatively empty. There was some hypertrophy of the lymph endothelium and in other areas there was interstitial hemorrhage which completely replaced the normal splenic elements. Diagnosis: Rupture of spleen, presumably at the hilus, with extravasation of large amounts of blood beneath the capsule and secondary rupture of the capsule.

Autotransfusion is an extremely valuable supportive measure in such instances as have been previously described. The sterile apparatus necessary for this procedure may be kept available in all surgical pavilions in anticipation of just such contingencies. One never knows whether or not the next anticipated perforated ulcer might not turn out to be a spontaneous rupture of the normal spleen. The blood is usually desperately needed and although a great deal of the blood may be clotted, sufficient can be collected in liquid form to be of value in preventing profound shock or a fatality. The apparatus consists of the ordinary 1,000 cc. bottle such as is universally used in the parenteral administration of electrolytes. Into this is placed 100 cc. of 5 per cent sodium citrate. A two-hole rubber stopper is used. Through one opening a glass tube is connected by rubber to



any source of suction. A glass tube passing through the other opening is connected to the suction tip. This apparatus can be kept in sterile condition, ready for use at an instant's notice. The liquid blood is sucked into the collecting bottle and after the entire amount is collected, normal saline is added to bring the volume to 1,000 cc. This is then stirred and is strained through six thicknesses of ordinary mesh gauze, using a glass funnel. It is then ready to be administered as an autotransfusion.

#### SUMMARY AND CONCLUSIONS

Two instances of spontaneous rupture of the normal spleen are reported. A presumptive diagnosis was made in the second case. In both instances a marked preoperative elevation of the polymorphonuclear count in the differential was noted. In neither instances was there clinical evidence of severe hemorrhage in spite of the presence of formidable quantities of blood in the free peritoneal cavity. Kehr's sign was present

in the second case. In neither instance was the so-called diagnostic x-ray evidence of dilatation of the stomach and serrations along the greater curvature noted on pre-operation survey films of the abdomen.

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# CALCIFIED MUCOCELE OF THE APPENDIX

J. PEYTON BARNES, M.D.

*Houston, Texas*

**M**UCOCELES of the appendix are rather rare and are very seldom diagnosed preoperatively. A calcified mucocele of the appendix is even more rare and this is the only one that the author has seen so far.

## CASE REPORT

Mrs. A. B. C., age seventy-nine, a white, widow, first consulted the writer on October 15, 1943. Her chief complaint was attacks of pain in the right upper quadrant which were very severe. The pain radiated to the right back. These attacks began some twenty years ago, but only in the past few years has she required hypodermics in order to obtain relief. The attacks were usually associated with a good deal of nausea but no vomiting, except rarely. She had a good deal of indigestion, gas on the stomach and belching, but this was mostly during an attack.

Previous clinical history revealed that the patient had the usual childhood diseases and had typhoid fever in 1911. She was in bed three months with this but remembers no definite complications. She has had much trouble with constipation all her life. She has never been jaundiced and has had no operations. She had eight children and two miscarriages; most of the eight children are living and well at present.

Examination revealed the following: temperature 99°F., pulse 84, blood pressure 140/80. The lungs were negative. The heart was not enlarged and the rate was not excessive. No murmurs or arrhythmias were noted. The pulse was of good volume, regular and the peripheral arteries were not excessively thick or stiff. The abdomen was somewhat distended. Definite tenderness with slight rigidity was noted over the gallbladder area. A tender, palpable mass was felt in the gallbladder area. Murphy's sign for gallbladder disease was positive. The liver and spleen apparently were not enlarged. In the right lower quadrant there was a very hard, rounded mass which was freely movable within certain limits. It was not

definitely associated with the kidney. Its extreme hardness was noteworthy. Thinking perhaps it was an inspissated intracecal mass, she was sent home to take a laxative that night, to be followed with an enema the next morning after which she was to come back for a re-check. The mass was unchanged in any respect following the procedure first mentioned.

The pelvic examination was negative in every way. An x-ray study was done at St. Joseph's Infirmary by Dr. C. P. Harris and was as follows: November 1, 1943: Mrs. Sallie C. Gallbadder and gastrointestinal series:

"*Preliminary Roentgenograms:* No shadows were seen suggestive of opaque urinary calculi. There is a round calcific density in the right lower quadrant which measures about 5 cm. in diameter. (Fig. 1.)

"*Cholecystograms (oral method):* There was no evidence of concentration of the dye in the gallbladder, and gallstones were revealed within the gallbladder.

"*Barium Meal Examination:* The barium meal passed through the oesophagus normally. There was a fairly large diaphragmatic hernia through the oesophageal hiatus of the diaphragm. The stomach and duodenum filled normally and showed no evidence of an organic lesion. There was a diverticulum at about the junction of the duodenum and jejunum, which measured about 2 cm. in size. (Fig. 2.)

"*Six-Hour Examination:* The barium meal was distributed in the lower ileum and proximal portion of the colon. (Fig. 3.)

"*Twenty-four Hour Examination:* The head of the barium meal had reached the rectum. There was a residue in the proximal portion of the colon, and the rounded calcific mass in the region of the cecum appeared to be more opaque than prior to administration of the barium meal. (Fig. 4.)

"*Barium Enema Examination:* The colon filled almost completely and multiple diverticula were present in the sigmoid. The cecum and ascending portion of the colon were markedly dilated and the round mass previously described apparently communicated with the colon. (Figs. 5 and 6.)



FIG. 1. Scout film showing round calcific density in right lower quadrant.



2



3

FIG. 2. Note diaphragmatic hernia and large diverticulum of duodenum near duodenojejunal juncture.  
FIG. 3. Barium meal indicates mass near cecum.

"Conclusions: (1) Non-functioning gall-bladder which contains gallstones. (2) Diaphragmatic hernia through the oesophageal opening of the diaphragm. (3) A diverticulum was present on the ileum at junction of the duodenum and jejunum. This diverticulum emptied normally. (4) The colon showed multiple diverticulæ in the sigmoid region, and the

cecum and ascending portion of the colon were dilated. There was a round, dense shadow at the lower margin of the cecum which became more opaque after administration of the barium meal. This shadow is not definitely identified. It is possible that it does not communicate with the cecum."

She was advised that the main source of



FIG. 4. Mass appears slightly more opaque than in Figure 1.



FIGS. 5 and 6. Note dilatation of cecum and ascending colon. Roentgenologist thought a communication was possibly present between mass and colon.

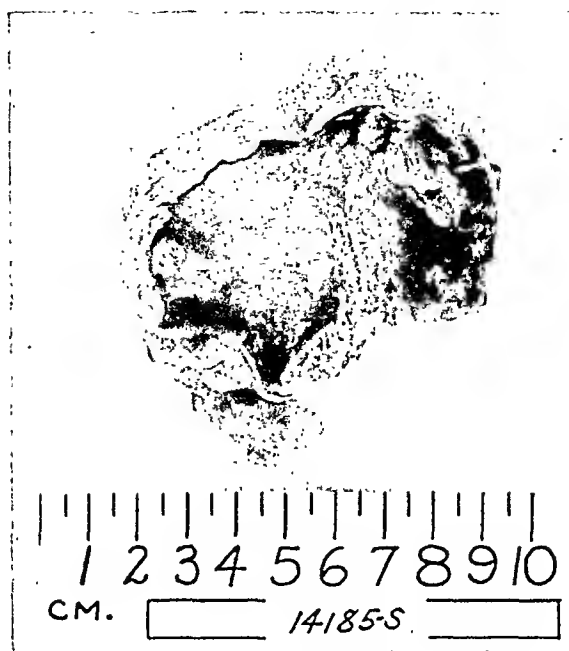


FIG. 7. The round mass as seen when cut open; the walls had to be cut with a small saw.

trouble was the diseased gallbladder and that it should be removed. She was also advised that no diagnosis of the ileocecal tumor had been made, and that as it did not appear to be troubling her much its removal was not seriously contemplated. The diaphragmatic hernia and the diverticulum of the jejunum also were not considered for surgical treatment, due respect being had for her age and general condition and for the fact that the hernia and diverticulum apparently were giving her little if any trouble.

She entered St. Joseph's Infirmary November 17, 1943. At that time her physical findings were as reported. Her blood showed: hemoglobin, Sahli, 75 per cent; erythrocytes, 4,240,000; leukocytes, 8,700; small lymphocytes, 33 per cent; polymorphonuclears, 65 per cent; basophiles, 2 per cent; urinalysis: Yellow, clear, acid, specific gravity, 1.015; albumin, negative; sugar, negative; casts, none; mucus, one plus. Epithelium, few, pus, occasional; bacteria none.

Operation was done November 18, 1943, using cyclopropane anesthesia. An upper oblique incision was used, cutting the aponeurosis of the external oblique transversely and splitting the internal oblique and transverse in the line of their fibers. The right rectus was cut transversely. The gallbladder was very contracted, adherent and difficult to dissect

but was found filled with stones on final removal. Removal was done from within out, carefully ligating the cystic duct and artery.

After this the ileocecal mass was brought up. Even then it was hard to ascertain its origin. It was attached to the cecum exactly where the appendix normally arises. It shelled out fairly easily with little bleeding and was as hard as a rock. There was some mucinous material on its outer surface; this mucinous material had exactly the same general physical appearance and characteristics as the mucinous material found in the more common pseudomucinous cyst of the ovary. None of this material was found elsewhere in the abdomen. The ovaries were entirely atrophied and showed no signs of any disease whatever, there was no cyst, even a small one, in either ovary. No appendix could be found after the removal of this tumor mass, no opening into the cecum or ileum could be determined, as apparently this mass was completely sealed off from the gastrointestinal tract. A free graft of omentum was tacked over the site of removal and, after placing a single Penrose drain in the foramen of Winslow, the abdomen was closed in layers.

The *pathological report* on November 19, 1943, by Dr. A. H. Braden was as follows: "A gallbladder that measures  $9 \times 4\frac{1}{2}$  cm. It has a thickened wall and contains multiple calculi. the largest of which measures 1 cm. across,

The mucosa shows extensive inflammation and necrosis.

"A mass removed from the region between the cecum and the ileum measures 9 cm. across and 6 cm. in diameter. The wall shows extensive calcification and the cavity is filled with thick, mucinous material. (Fig. 7.)

"*Diagnosis:* Cholecystitis; cholelithiasis; calcified mucocele of the appendix."

The patient made an uneventful recovery, but did develop an auricular fibrillation on the second postoperative day. This was controlled by digitalis.

She went home on the seventh day and got out of bed the same day without ill effects. She celebrated her eightieth birthday two weeks after the operation and has been well ever since.



# SUBCUTANEOUS, SUBTOTAL TRAUMATIC AMPUTATION OF A THIGH

JOHN R. VASKO, M.D.

*Oakland, California*

**C**RUSH injuries and incomplete traumatic amputation of fingers and toes are commonplace; injuries of limbs are not as common but are not rare. Conservative treatment of these injuries often results in the saving of these appendages and limbs. As in finger injuries surgical repair of the limb is highly desirable because what frequently appears to be a hopeless injury turns out to be a striking success.

The problem in traumatic incomplete amputations through the larger portion of the extremities, however, is always difficult and the successes more unusual than those obtained in finger injuries. Conservative operative treatment is less certain because of the larger mass of soft tissues and because a larger blood supply is necessary. It is idiomatic that the volume of blood supply necessary is proportional to the tissue mass to be supplied and hence the blood volume necessary diminishes as the wound moves distally. The one essential which will determine success or failure is an adequate blood supply.

The following case report is interesting because it was almost entirely a subcutaneous injury which was quite extensive; it was a subtotal section of both soft and bony tissues through the thick part of the thigh. As the author had never read of a similar case it was believed worth while reporting.

A brief reference to the literature revealed at least one author, Abdelsamie,<sup>1</sup> who advocated early amputation in severe crush injuries to the extremities and who stated that with delay shock comes quickly and death follows. Few other references were found on crush injuries to the extremities. However in severe injuries and

incomplete amputations of the extremities most authors advised conservative treatment.<sup>2,3</sup> Jones advocated conservative surgery if at least one large artery remains.

In this case and in many others due to gun shot and shell fragment wounds in all parts of the extremities, the author's experience coincided with that of Jones. The ultimate function was not always normal but the limb was usually saved if at least one large artery remained.

## CASE REPORT

A young negro male, A. G., aged thirty-five, was injured on September 15, 1943 when a car backed up and caught the patient between the back end of the truck and the edge of a work bench crushing his right thigh in the middle third. He was at once taken to the hospital for treatment; his general condition was moderately good, his pulse was 120, respiration 35, temperature 101.8°F. and no appreciable shock was evident. Locally the entire right thigh was markedly ballooned out, swollen and distended, and upon palpation the skin was tense throughout the circumference. There was a dark discoloration of the skin over two areas, about  $\frac{1}{2}$  by 2 inches on the anterolateral surface of the thigh but no perforations were found except for a tiny puncture wound posteriorly which was considered superficial.

No indentations were felt in the thigh on the first examination and motor power and sensation in the leg below the knee were normal. He was immobilized in a Thomas splint and traction was applied while roentgenograms were taken. These revealed a transverse fracture of the middle femoral shaft with marked displacement posteriorly of the distal fragment. He was given 1 cc. tetanus toxoid and  $\frac{1}{2}$  gr. of morphine and put to bed with a dressing to the posterior wound. About two hours later it was noticed that the posterior wound continued to bleed through the dressing.

His pulse rose to 128, respirations to 40 and temperature to 102°F. It was then determined to explore the wound keeping in mind the probability of a compound fracture with injury to the hamstring muscle group. At the onset of operation the blood pressure was 114/68 and pulse 112.

It was planned to reduce and immobilize the fracture with the Anderson pin method, utilizing external bars for fixation. Therefore, two pins were placed obliquely in the greater trochanter area and two more in the lower lateral femur. After fixation was complete the patient was turned over and the perforating wound débrided. Upon enlarging the wound to find the bleeder, the exploring finger at once revealed an enormous defect in the muscle bellies of the posterior thigh. The incision was enlarged to 5 inches and complete severance of all musculature except a thin strip covering the bone in which lay the sciatic nerve was found. There was pulping of the muscles over a width of about 2½ to 3 inches from one side of the thigh to the other and much of the crushed muscle could be picked out. Excision of the edges of the crushed muscle was done both distally and proximally, but still the muscle did not bleed readily nor contract upon pinching. A 2 inch wide gap in the muscle had already been made and it was feared that if the gap was made larger it could not be closed. Therefore, it was decided not to excise more muscle but to leave the rest in hope that the damaged ends would become replaced with scar. The sciatic nerve was not exposed as prior to operation there was no evidence of sciatic nerve injury. Apposition of the muscle bellies was made with some difficulty by interrupted chromic No. 1 sutures after 10 Gm. of sulfanilamide powder were left in the wound. Fascia and subcutaneous tissues and skin were likewise closed in layers, but the fascia could not be closed completely and a ¼ inch gap remained. One rubber drain was left in the wound for drainage. Assuming that if the heavier musculature were crushed posteriorly certainly the anterior group also was injured, further deep palpation anteriorly was made which revealed indentation in the continuity of the quadriceps muscle anterolaterally under the bruised skin area. A 6 inch transverse incision was made through the tense skin and fascia, the edges of which pulled apart at once. Masses of pulpy muscle tissue were found and no muscle con-

tinuity was found anywhere anterior to the bone. Exploration revealed a very small strip of intact musculature laterally and a small but larger bundle medially enveloping the femoral artery which could be palpated and which felt intact. All the loose masses of pulped muscle were removed and all the muscle ends freely excised until a 2 inch wide gap was present. Although the muscle ends still did not contract and were dull in color, it was decided not to remove more for fear of not being able to close the wound. We chose to let subsequent scar replacement maintain continuity rather than to have a perfectly débrided but useless muscle. The bone ends were reduced and a six hole bone plate was applied, the end of the distal fragment being forcibly tapped to cause impaction at the fracture line before tightening down the screws. One test screw which was first placed at one end of the plate and incompletely tightened was forgotten so that only five screws held the plate firmly, three above and two below the fracture line. Closure of the muscle wound was made with loosely tied interrupted chromic sutures. The fascia was extremely tense and complete closure was found to be impossible, a ¼ inch gap remaining. The skin was closed with interrupted silk except for a small area which had been bruised anterolaterally and which was not excised because of the already tense skin. Closure of the skin was already difficult and further excision of the skin was decided against as it was uncertain how much of the bruised skin was devitalized. Eight Gm. of mixed sulfa powder were left in the wound but, as occurred in the posterior wound, much of it was lost with draining blood at the site of the rubber drain. The external bar supports were tightened down and the patient was put to bed.

Whole blood in 500 cc. amounts were given to the patient on September 16th, 19th and 23rd, and the blood count rose from 2,770,000 on September 16, 1943, to 3,320,000 on September 26, 1943, and subsequently it gradually rose to normal. The Wassermann test was negative as were the urinalyses. There was never any indication of anuria which occurs in some crush injuries. Gas antitoxin 3 cc. was given intramuscularly on September 16, 1943, and sulfadiazine was begun with 2 Gm. and thereafter 1 Gm. every four hours. His blood level rose to 9.1 mg. per cent on September 17, 1943, and it fluctuated there-



after until October 17, 1943, when the sulfadiazine was stopped.

The patient's general condition was never bad and his temperature never rose higher than 102°F. It was most interesting to observe the progress of the injured thigh. For thirty to thirty-two days the thigh remained swollen, edematous and tense. From the first there was some serous drainage from both wounds which was accompanied on September 21st by a bulging of the medial thigh. This was aspirated but no fluid was found. On September 22nd both anterior and posterior wounds were explored but no pockets were found. On October 1, 1943, several pockets were opened up and were found to be filled with necrotic tissue. The necrotic tissue was excised, the pockets dusted with sulfanilamide powder and a vaseline gauze drain was left in. The skin, which after injury appeared severely bruised on the anterolateral thigh, became necrotic and was on this date excised.

The drainage gradually decreased and was at no time purulent, being more of a serous type. During some of the dressings small amounts of necrotic tissue were removed but there was never any massive necrosis. Where the necrotic tissue had been excised granulating areas resulted, one was about 1½ by 1½ inches and the other about 1 by 1 inch. On November 1, 1943, pinch grafts were applied to the granulating areas. Another narrow granulating area on the posterior medial aspect of the thigh was excised and a closure of the wound was made. Healing was uneventful. Roentgenograms of the femur taken October 14, 1943, showed good position and a small amount of callus at the lateral margin of the fracture line.

On December 12, 1943, the pins were all removed and external fixation was discontinued. Clinical union was solid and a Thomas splint with a Pierson attachment was applied for further protection and to permit motion of the knee. Some active contraction of the vasti could be seen and felt. On this date the knee moved from 180 to 135 degrees. Roentgenograms taken January 15, 1944, revealed some slight angulation of the bone plate and incomplete union; there was little callus on the plate side of the femur where it appeared that the plate was holding the fragments apart. The plate was removed January 17, 1944, and because of insufficient callus on only the medial

side, a sliding graft was made and external support provided with a double hip spica cast. On March 17, 1944, the cast was removed and both clinical and x-ray union were found present. Exercise and physiotherapy was again begun and walking with crutches was permitted on April 8, 1944, when there was active motion in the knee from 180 to 135 degrees. A caliper splint was applied for protection and gradual improvement was noticed with use, exercises and physiotherapy. Strong active contractions of all thigh muscles were present and in the quadriceps and hamstring muscles there was continuity of the proximal and distal muscle bellies. Thus the fibrous bridge joining the two was a functioning one. The muscle bellies both above and below the area of injury appeared to contract actively and the strength was about 75 per cent normal. By May 27, 1944, the patient walked without support but the knee was still limited, motion being 180 to 135 degrees. Further improvement was anticipated but the patient was returned to the mainland and hence the final result is unknown. An attempt to reach him by correspondence failed.

#### COMMENTS

One point of interest in this case was the decision to avoid complete débridement. Usually complete débridement is necessary for the best results but such procedure here was feared. Much divergence of opinion might be found regarding the decision to leave damaged tissue in a wound but the good result in this case would appear to justify the method employed. In favor of the conservative method used was the avoidance of resecting some good muscle tissue with the devitalized and of the subsequent necessity to make strong traction with sutures on the muscles for apposition which would diminish still further the already damaged blood supply. To do a thorough débridement would assuredly result in a clean granulating wound but one which might be impossible to close at a later date, remembering that such an extensive gap would have been circumferential except for a slip of muscle medially and laterally. There was a definite risk of massive necrosis. However, such a result

was not feared as the future possible necessity to excise this tissue would probably result in a wound no worse than that deliberately obtained by complete primary resection. Since gross contamination did not occur and because early treatment of the patient was possible, infection was not anticipated. The use of sulfa drugs probably helped to prevent this.

An intact skin with its intact blood supply in addition to the femoral artery was no doubt an important factor in the saving of this limb. What little muscle remained also helped in this respect.

Also interesting was the fate of the muscle bellies distal to the wound as much of its innervation must be assumed to have been sectioned. Yet after healing there was felt what was believed to be muscle contraction both anteriorly and posteriorly. The innervation of the quadriceps, the hamstring muscles and adductors occurs chiefly in the proximal muscle bellies of these muscles, but some nerve branches to the quadriceps also pass down laterally<sup>4</sup> which may have been spared from injury

just as were the femoral artery and sciatic nerve. As the thigh muscles become tendinous in their distal portions their function would be only partly impaired by section of the nerve supply to the lower portions. Clinically, the thigh muscles functioned fairly well in the act of walking in spite of the partial loss of their innervation and the muscle damage.

#### SUMMARY

A case report was given of a severe crushing injury to the thigh which was almost entirely subcutaneous and hence was called a subcutaneous subtotal, traumatic amputation. The treatment was conservative and successful.

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# FAILURE OF ROTATION OF MID-GUT LOOP\*

GREGORY L. ROBILLARD, M.D., WILLIAM J. FUSARO, M.D. AND CELSO R. GARCIA, M.D.  
*Brooklyn, New York*

THIS case is reported because it is of great interest to note that this boy, although fourteen years of age, had not experienced previously any digestive difficulties not only in his childhood but in his infancy as well. In most cases of failure of rotation or partial failure of rotation of the mid-gut loop symptoms are evident in the first few days of life. In one series<sup>1</sup> 65 per cent of the patients developed symptoms within the first two days of life and 85 per cent within the first two weeks.

In order to better appreciate the errors of development of the intestinal tract one should familiarize himself with its normal embryologic development. The contributions to the literature of Dott,<sup>2</sup> Frazer and Robbins,<sup>3</sup> Gardner and Hart<sup>4</sup> and Haymond and Dragstedt<sup>5</sup> are excellent.

## CASE REPORT

D. B., a fourteen year old boy, was admitted to the Norwegian Hospital on December 21, 1945, complaining of severe abdominal pain accompanied by nausea. One week prior to admission the patient complained of abdominal pain which was not as severe as that on the date of admission and which was not accompanied by either nausea, vomiting or diarrhea. The patient recovered from the first attack uneventfully in about one day. On the day of admission, while quarreling with his brother shortly after the noontime meal, the patient received a blow in the mid-abdomen which he dismissed without further consideration. Several hours later the patient was seized with sudden, severe abdominal pain which was most severe in the epigastrium. The patient was nauseated and upon admission began to vomit undigested food particles quite forcefully but not to the extent of projectile vomiting.

The family history was irrelevant. The past personal history revealed a normal full term

spontaneous delivery. He was breast fed for a little over six months. Usual dietary and vitamin support were adequate. He had no digestive difficulties and progressively gained weight as an infant. He had measles and chicken pox at the age of two; he also had at the age of eight a sporadic case of poliomyelitis involving the left lower extremity from which he had an uneventful recovery without any after effects.

Physical examination revealed a fourteen year old, well developed and well nourished white male who although rational was uncooperative and writhing with pain. The throat, heart and lungs were normal. The abdomen was flat but was held rigidly, the right rectus muscle being definitely in severe spasm. No masses were palpable. Tenderness was elicited in both lower quadrants and along the right lateral aspect of the abdomen. The tenderness was extreme over McBurney's area and rebound tenderness was also very marked over the same area. Rectal examination proved negative.

On admission the temperature was 100°F., pulse 84, and respirations were 20. Blood pressure was 112/74. Examination of the blood revealed a red cell count of 5,000,000 with a hemoglobin of 106 per cent (Sahl); the white cell count was 15,000 with 82 per cent polymorphonuclears and 18 per cent lymphocytes. Examination of the urine was negative.

With the aforementioned findings, a diagnosis of acute appendicitis was made and under general anesthesia a right McBurney incision was made which revealed a bluish peritoneum. Serosanguineous fluid was encountered in the cavity with the small intestine appearing deeply cyanotic and hemorrhagic. The McBurney incision was enlarged by the method of Weir. Exploration of the abdomen revealed the small intestine to be encapsulated in a mass the size of a football in the upper abdomen. The small intestines were delivered from the peritoneal cavity starting from the ileocecal junction to the ligament of Treitz and the

\* From the Department of Surgery, Norwegian Hospital.

mass was reduced. The entire length of the small intestine was hemorrhagic and deeply cyanotic. The mesentery of the small intestine was also very hemorrhagic with the vessels markedly engorged. Following application of hot laparotomy pads to the small intestine and its mesentery, the color was observed to improve considerably. Further work or exploration at this time was considered not advisable because of the patient's extremely poor condition. The small bowel was repositioned and the color remained improved. A cigarette drain was inserted, the abdomen was hurriedly closed and the patient was returned to a shock bed. Despite administration of 500 cc. of plasma during the operative procedure the patient was still in shock upon being returned to bed, at which time the blood pressure could not be elicited.

Under treatment the patient slowly rallied to consciousness and his general condition became improved. Vomitus and Wangenstein returns were coffee-ground in nature. The patient became distended and Harris drip irrigations were instituted with serosanguineous fluid being returned. The patient's hydration was closely watched and adequately maintained by means of the fluid balance chart. Protein, electrolyte and vitamin wants were likewise adequately maintained.

The patient's general condition continued to improve and on the tenth postoperative day he was allowed out of bed in a chair. An hour or so after being up out of bed the patient complained of severe epigastric pain. The abdomen was soft and flat. Later in the evening the patient vomited 800 cc. of undigested food. The temperature was 100.4°F., pulse 92 and respirations 22. Morphine sulfate gr.  $\frac{1}{6}$  was given for the pain. The vomiting as well as the pain was relieved until the following morning when the pain returned again. The abdomen was still soft and flat and remained so all day. The following morning slight distention in the epigastric area made itself evident. A flat x-ray plate of the abdomen in the upright position revealed dilatation of the upper part of the small intestine and evidence of the presence of a fluid level. From the past history and the evidence on hand the presence of an internal hernia with partial intestinal obstruction was suspected.

An emergency operation was performed under continuous fractional spinal anesthesia

and the opinion of internal hernia with intestinal obstruction was substantiated for upon opening the abdomen by means of a paramedian incision, a globular sacculated mass was found occupying the right upper quadrant. The sac was opened and its contents, comprising about 8 feet of distended small bowel, were delivered from the abdominal cavity whereupon the remainder of the abdominal organs were more plainly visualized. The cecum was anomalously situated, being found in the epigastric region overlying the bodies of the dorsal vertebrae. The ascending and transverse colons were situated along the left border of the dorsal vertebrae from above downward, toward the pelvis and then extended upward to join the descending colon at the splenic flexure. The descending and sigmoid colon were normally situated. At the end of the cecum was found an extremely long appendix, about 16 to 18 cm., retrocecal and bound down by firm adhesive bands from the lateral abdominal wall and also from the area where the ligament of Treitz is normally attached. These adhesions formed the neck or constricting band of the hernial sac. The appendix was removed and the adhesive bands were severed. The duodenal loop was then attached to the severed lateral band for support. The picture was clearly one of failure of the bowel to rotate completely, with arrest of the rotation at an early fetal stage.

The second postoperative course was uneventful until the fifth postoperative day when the patient began to complain of headache and pain upon movement of his neck. The temperature rose to 104.6°F., pulse to 130 and respirations to 35. Physical examination revealed an alert, pale, undernourished male with marked nuchal rigidity and pain on flexion of the head. Positive Brudzinski signs were elicited. The pharynx was slightly injected; the heart and lungs were negative; the abdomen was soft and flat and the operative wound was healing by primary union. On the following day the patient had a convulsive seizure and was transferred to the medical service for treatment.

Examination of the blood revealed a red blood cell count of 3,290,000 with a 66 per cent hemoglobin, a white blood cell count of 9,450 with 65 per cent polymorphonuclears, 32 per cent lymphocytes, 2 per cent eosinophiles and 1 per cent monocytes. Examination of the spinal fluid revealed a cloudy fluid with a large increase in cells, 95 per cent of which were poly-



FIG. 1. Immediate film after opaque meal.



FIG. 2. Five-hour film after opaque meal.

morphonuclears. No organisms were seen on smear or in the culture. The sugar was normal while the globulin was slightly increased. The patient was placed on penicillin-sulfadiazine meningitis therapy but the penicillin was soon discontinued on the third day as the clinical picture was that of an influenzal type of meningitis.

The patient recovered rapidly and was discharged on the nineteenth postoperative day (dated from the second operation) after undergoing a gastrointestinal series and a barium enema. He has enjoyed perfect health for the past six months with regular bowel movements each day and no digestive disturbances.

#### COMMENT

The gastrointestinal series taken just prior to discharge revealed a normal stomach with no obstruction at the pylorus or in the duodenum. The immediate film after the opaque meal (Fig. 1) reveals the barium passing through the pylorus and filling the duodenum and part of the jejunum. The five-hour film (Fig. 2) shows evidence of hypermotility with the meal having passed into the small bowel and through to the large bowel. Nearly all the proximal half

of the large bowel is filled with barium. In this film it will be noted that the entire small bowel lies to the right of the vertebral column. The cecum can be seen overlying the lumbar vertebrae in the midline. It proceeds to the left and downward and what would be the ascending colon is seen to be to the left of the vertebral column and proceeds downward into the pelvis. What would be the transverse colon proceeds upward lying lateral to the loop just described and terminates at the normal splenic flexure. The twenty-four-hour film (Fig. 3) shows the barium to have passed through the previously described large bowel; the descending colon is seen in normal position and some redundancy of the sigmoid is evident.

One of the barium enema films (Fig. 4) shows an excellent picture of the entire large bowel. The dense shadow reveals the redundancy of the sigmoid in the midline. The lesser dense shadow is then seen to extend upward along the lateral abdominal wall to the splenic area. This represents the descending colon in its normal position. From the splenic flexure the shadow is seen



FIG. 3. Twenty-four-hour film after opaque meal.

to descend downward back into the pelvis, this loop represents the transverse colon in its abnormal position. The ascending colon and cecum are then represented by the more medial shadow which extends upward and terminates at the midline overlying the lumbar vertebrae. The pattern of the large bowel as seen in this film is almost identical with that of Sturgeon's case.<sup>7</sup>

This boy, as is clearly demonstrated, is a true case of failure of rotation associated with the usual abnormal peritoneal bands. It is worthy of note that as previously pointed out he had no digestive symptoms prior to admission to the hospital. He exhibited the usual signs of intestinal obstruction and at operation it was evident that volvulus with marked interference of the circulation was present as a result of the abnormal peritoneal bands constricting the enveloped loops of small intestines.

A review of the literature with a tabulation of 103 reported cases was given by Gardner and Hart<sup>1</sup> in 1934 and since then many others have been added. The majority of cases involve malrotation or partial



FIG. 4. Barium enema film.

failure of rotation in the second stage. The usual result is a narrowing of the duodenocolic isthmus. This failure of the broadening of the base of the root of the mesentery favors the occurrence of volvulus and intestinal obstruction. The volvulus is not thought to exist prior to birth but is believed to occur shortly after birth when the motor activity of the intestines sets in. This being the most common type of disturbance of rotation it is easy to understand why the majority of cases occur very early in life.

The diagnosis is sometimes very difficult to make but should be suspected when the vomiting comes on in the first few days of life in contradistinction to pyloric stenosis in which the onset is usually after a week. Another distinguishing feature is that pyloric stenosis cases rarely exhibit bile in the vomitus, a fact which definitely establishes the site of obstruction beyond the ampulla of Vater. The vomiting is rarely projectile in character unless there is marked pyloric spasm coexistent. Differentiation from intrinsic duodenal atresia causing obstruction may be made by x-ray

study. If the opaque meal or barium enema reveals a large bowel entirely on the left side, then malrotation with adhesions about the duodenum would be diagnosed; otherwise, with a normal bowel pattern, the obstruction would be considered intrinsic in character.

There is a smaller group of patients in whom the onset of symptoms occur later in infancy or childhood or even in adult life. They may be divided into two groups: The first group comprising those patients in whom the history is one of intermittent attacks with interval periods of greater or lesser duration in which they are free of any symptoms. This group comprises those older cases of volvulus that spontaneously subside and as a rule are not associated with the presence of abnormal peritoneal bands. Spontaneous recovery is usually due to the decompression being accomplished by the violent attacks of vomiting. These children or adults are usually told they have "sensitive" stomachs or "nervous" indigestion until some day, either by x-ray study or at operation, in one of the attacks the true nature of their condition is ascertained. The second group of older patients comprises those cases that are associated with the presence of abnormal peritoneal bands and in whom there is a history of more or less constant discomfort and inability to digest a regular meal. These patients are usually treated for chronic gastritis, gastric ulcers, chronic appendicitis, chronic cholecystitis and gastrointestinal allergy until some day an accurate diagnosis is made by x-ray or at operation. This group of patients is prone to limit their food intake and as a result malnutrition sets in. The patient in the case herein reported had dense bands and belongs to this second group although clinically his symptoms were not unlike those of the patients in the first group, in the sense that one previous attack was reported but this only one week prior to admission to the hospital. In other words our case was unique in that no symptoms at all occurred for a period of fourteen years.

The abnormal peritoneal bands as pointed out by Frazer and Robbins<sup>3</sup> many years ago are the result of the malrotation or failure of rotation and not their cause as still thought by many men. They showed that there are certain constant and well established areas of thickening in the parieties of the peritoneal cavity which are the normal results of intestinal rotation in the third stage. When abnormal bands are found at operation, most surely if searched for, evidence of some malrotation will be found. Likewise if evidence of malrotation is discovered first, a search for abnormal bands, especially in the area about the duodenum, may prove very helpful for their subsequent release will prevent a future cause for intestinal obstruction. This we were unable to accomplish in our case due to the extreme condition of the patient, but if we could have made the search, the second attack and operation could have been avoided. The first cases of Haymond and Dragstedt<sup>5</sup> and of Gardner and Hart<sup>4</sup> belong in these two groups.

Cases of third-stage failures of rotation are not as common as second-stage failures but many have been reported. Grant<sup>8</sup> reported a case of a seventy-six year old man with a cecum and ascending colon that had a completely free mesentery and was freely movable and also a woman fifty-seven years old with a freely movable cecum having a complete mesentery. The woman also had a series of adherent U shaped loops of duodenum and jejunum. She had complained of epigastric fullness and pain for years. McIntosh and Donovan,<sup>1</sup> case No. 16, was a girl nine years of age who had had attacks of nausea and vomiting every twelve to sixteen months lasting two to five days. Her cecum was freely movable and at operation was sutured to the right lateral parieties.

Cases of reversed rotation in which the distal end of the mid-gut loop enters the abdomen first instead of the proximal end are very rare, only seventeen cases having been reported. Dott<sup>2</sup> reported a case in a sixty-eight year old man and McIntosh

and Donovan<sup>1</sup> reported a case (No. 19) in a thirteen year old boy. In these cases the rotation is 90 per cent clockwise instead of 270 per cent counterclockwise and the superior mesenteric artery and the second portion of the duodenum lies in front of the transverse colon instead of behind it.

#### SUMMARY

The case report of a fourteen year old boy with failure of rotation of the mid-gut loop associated with abnormal peritoneal bands causing volvulus and intestinal obstruction is presented.

A brief resumé of the clinical status of the problem of intestinal rotation is given with a review of the literature.

The early diagnosis of these cases can be made easily only if the occurrence of the condition is kept in mind. Early diagnosis together with our present day knowledge of the physiologic requirements, both preoperatively and postoperatively, will render

our surgical corrections to be more successful than those of our predecessors.

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# MESENTERIC THROMBOSIS\*

DURAND BENJAMIN, M.D.

*St. Louis, Missouri*

THE first case of mesenteric thrombosis to be recorded in the literature was in the year 1843 and was reported by Tiedemann. However, it was not until 1895, or fifty-two years later, that the first case of mesenteric thrombosis was successfully resected by Elliott. That the condition is a surgical catastrophe is well exemplified by the fact that until the present time only 116 successfully resected cases have been reported in the literature. Of these 116 patients only twenty-six had more than 200 cm of bowel involved. That the treatment and diagnosis of the condition has improved is illustrated by the fact that in 1921, Klein reviewed the literature and found that there were only twenty-four cases of successful resection reported. Since that date, or in the last twenty-five years, an additional ninety-four cases have been reported.

The etiology of the disease is varied. It may be a result of arteriosclerosis, cardiac disease, liver disease, splenic anemia, polycythemia, or antecedent surgery. The causative factor of thrombosis may be either embolic or thrombotic. The embolic factor is believed to be more frequent and it usually has a cardiac or acute valvular lesion as the producing factor. The thrombotic factor is less frequent and is usually secondary to embolism. Primary thrombosis is rare. The occlusion may be either arterial or venous. The arterial type may be either general or segmental and may be due either to emboli or thrombi. The venous type, however, is always thrombotic. The manner in which the disease occurs is of far greater importance than is the location of the condition. In the embolic type, which most commonly occurs in

patients with cardiac or valvular disease, the embolus arises in the left side of the heart from vegetations on the valves or from a thrombus in the auricle. When the embolus lodges in one of the larger branches of the superior mesenteric artery, infarction results. The superior mesenteric artery is more frequently involved, particularly in embolism, because of its earlier exit from the aorta and also because it is a more direct continuation of the aorta than is the inferior mesenteric artery.

Venous thrombosis of the vessels is usually associated with infection in organs or viscera which drain into the portal circulation and is preceded by appendicitis, inflammatory pelvic disease or ulcerating colonic carcinoma. One should remember in secondary thrombosis when there are no inflammatory lesions in evidence that injury to the vessel walls may be a factor.

The condition which results from vascular occlusion is infarction and is of the hemorrhagic and not the ischemic type. Usually the lower part of the jejunum and ileum is involved. Grossly, the wall of the intestine is thickened and edematous and rapidly becomes purplish-black in color and gangrenous. The bowel wall loses its luster and its elasticity. The lumen of the bowel contains thick, semicoagulated blood which seeps through to the peritoneal cavity producing the bloody ascites which is always associated with the condition. Peritonitis is most common in this condition but perforation is relatively rare.

Microscopically, the lumen of the bowel is filled with a large amount of hemorrhagic fluid. The mucosal lining of the bowel wall shows all stages of degeneration from edema to a condition of true necrosis.

\* From the Departments of Surgery, St. Louis University School of Medicine and St. Anthony's Hospital, St. Louis, Mo.

Edema is seen to be marked in the submucosa. The blood vessels are dilated and filled with large quantities of erythrocytes. The muscular layer and serosal layer show a hemorrhagic reaction.

The condition of mesenteric thrombosis is rarely diagnosed preoperatively. It is most commonly mistaken preoperatively for intestinal obstruction, acute pancreatitis, perforated peptic ulcer or acute cholecystitis. The condition ordinarily has a sudden onset with severe central abdominal pain. This pain becomes colicky in about 50 per cent of the patients. Vomiting is marked from the onset and shock is usually present which varies with the degree of occlusion. Vomiting is overshadowed markedly by the severe pain which helps to differentiate the condition from intestinal obstruction in which the reverse is true.

This sign of pain is the first and the most constant sign of the condition. It is first intense and later becomes intermittent and colicky. Later, when the peritonitis develops, it becomes continuous. The abdominal signs are tenderness, rigidity and distention. Distention is present in about 70 per cent of the patients and one can also find ascites in about 80 per cent of the patients. There is almost always a diminishment in the auditory peristalsis. The temperature is usually subnormal and a rise in temperature is usually a late manifestation. This rise in temperature is preceded by a rise in the pulse rate. Hematemesis occurs in about 20 per cent of the patients and either diarrhea or constipation may be present although constipation is a more frequent finding than is diarrhea. Other signs which may be found are melena, tumor, restlessness, thirst or faintness. The white count may vary between 25,000 and 40,000 but the average white count is about 27,000.

Diagnosis may be assisted by a history of previous surgery, any evidence of other vascular condition and a diagnostic enema which may show intestinal hemorrhage and the findings just listed. When the abdomen is opened, there is an escape of blood-

stained fluid and in most cases there is a curious and characteristic smell of putrefaction.

Prognosis of the condition is, of course, very grave. However, the most hopeful thing about mesenteric thrombosis is the fact that it can be cured by surgery. It is well recognized that the mortality rate without surgery is 100 per cent although with the use of heparin, antispasmodics and penicillin this figure may have to be revised. Early diagnosis and immediate surgery offers these patients their only chance for survival. There is a high mortality rate following surgery but, nevertheless, the lowest figures for mortality are reported following surgery. The mortality rate is about 62.5 per cent. It is believed that resection is possible in 80 per cent of the patients operated upon within twelve hours, whereas only 15 per cent can undergo resection after that lapse of time. Prognosis is influenced by the length of bowel involved and on whether or not the bowel can be resected and the extension of the infarct stopped.

The treatment, as previously stated, is immediate surgery. It is important to excise well beyond the limits of the involved segment of bowel and to resect the mesentery down to its root. There is no place for conservatism in treatment of this condition. Excision of the bowel and mesentery is advised even in the most desperate cases in view of the fact that the mortality rate is 100 per cent without resection and is also 100 per cent with exteriorization of the bowel. It is possible to resect 30 per cent of the small intestine and still expect the intestinal tract to return to normal. The average length of the small intestinal tract is 20.5 feet although it varies from 10 to 28 feet. The treatment, therefore, is radical resection of the bowel and mesentery extending into uninvolved tissue, with anastomosis. Postoperatively, papaverine, heparin and penicillin may be used.

The following are two cases with successful resection achieved. Two extremes are

herein presented. The one case is a young female, twenty-seven years of age, with 99 cm. of terminal ileum involved, and the other is a sixty-one year old male with 366 cm. of proximal jejunum and ileum involved:

#### CASE REPORTS

CASE I. Mrs. V. R., aged twenty-seven, was admitted to the hospital, June 13, 1941. The chief complaint was pain in the left upper quadrant and vomiting.

Past history disclosed that the patient was operated upon on June 2, 1941, at which time a Baldy-Webster type of suspension for retroversion of the uterus was performed. A simple appendectomy was performed at the same time. The patient's postoperative course was simple and uneventful. The highest postoperative temperature was 100.4°F. and the temperature on the sixth day was normal and stayed normal. She was discharged on the tenth day with no complaints. She stated that she slept well that night but on arising the next morning she complained of pain in the left upper quadrant. As the morning progressed the pain increased in severity and she vomited twice. She stated that she had a small bowel movement but that there was no blood present in the stool. The patient was advised to return immediately to the hospital.

Physical examination revealed that the patient was a young female with normal development. She appeared to be acutely ill and moaned and complained of pain in the abdomen, more especially in the left upper quadrant. The heart and lungs were negative. Blood pressure was 110/80. The abdomen was flaccid and was not distended. There were no palpable masses and there was no rigidity. Tenderness was present and was most marked over the left upper quadrant. The liver, spleen and kidneys were not palpable.

Laboratory work revealed the following: Hemoglobin, 145 Gm., 93 per cent; color index, .9 plus; erythrocytes per cu. mm., 4,890,000; leukocytes per cu. mm., 14,700; stab cells, 10 per cent; segmented forms, 80 per cent; lymphocytes, 8 per cent; monocytes, 2 per cent. Preoperative diagnosis was mesenteric thrombosis and postoperative diagnosis was the same.

An incision was made to the left of the original wound and all superficial vessels were

ligated. Three feet of terminal ileum were excised and a side-to-side anastomosis of the ileum to the ascending colon was performed. The abdomen was closed without drainage and the patient was returned to bed in poor condition.

Gross findings revealed 39 inches of terminal ileum, dark and purple in color. The portion involved extended to a point within 1 inch of the cecum. The bowel was edematous and had lost its luster. The mesentery showed thrombosis of the vessels. The bowel was soft and friable.

*Diagnosis:* Gangrenous distal ileum.

The patient was given 500 cc. of plasma the night of the operation as had been done during operation. The patient's postoperative course was remarkably smooth and uneventful. There was no distention following surgery and the highest postoperative temperature was 101.6°F. The temperature became normal on the seventh day. On the fifth postoperative day the patient began to have bowel movements. These movements assumed the character of diarrhea and she had six to twelve bowel movements per day. The patient was discharged on the fifteenth postadmission day with the diarrhea still persisting.

The patient continued to have from five to ten bowel movements per day in spite of diet and administration of kaomagma, camphorated tincture of opium, belladonna and similar medication. This condition persisted for eleven months at which time there began a diminution in the fluidity and frequency of the movements. At the end of the sixteenth month the bowel movements were normal in character and in frequency. The patient has been perfectly well since that time and has had a normal pregnancy and delivery four years following thrombosis.

CASE II. Mr. J. H., aged sixty-one, was admitted to hospital, January 29, 1946. The patient complained of pain in the abdomen just below the umbilicus. The patient stated that he had had this pain off and on for the past four or five years. He had been under treatment about four years ago for the same complaint. He stated that recently the pain had been worse. After eating a fairly good-sized meal he said he became nauseated and had to vomit. There was no history of hematemesis. He also stated that his stomach was very "acid." The pain of which he complained

did not radiate but remained in the area of the urinary bladder. He stated that for years he had been troubled with "loose bowels." There had been no recent loss of weight. About four years ago he had the same symptoms and at that time lost about 40 pounds of weight. Stools had been normal; there was no hematuria, nocturia or polyuria. No pain or difficulty upon micturition was present. There was nothing significant in his past history other than an appendectomy forty-seven years ago.

Regional history was negative throughout except for the gastrointestinal history previously reported.

Family history disclosed the following. The patient was married and had three sons and three daughters who were living and well. His father died of "bladder trouble" and his mother was dead of unknown causes. Three brothers and two sisters were living and well. There was no history of tuberculosis, carcinoma, diabetes, hypertension or cardiac disease.

Physical examination revealed that the patient was a well nourished, well developed, white male lying in bed in acute distress. He complained of severe pain suprapubically.

The scalp was clean; there were no exostoses nor discharge or tophi of the ears; ear drums were normal. Examination of the nose was negative. Mucous membranes of the mouth were normal and there were no sores nor ulcers. His teeth were in poor condition with pyorrhea alveolaris present. The pharynx was normal; the tonsils were atrophic and the tongue was moist and protruded in the midline. No abnormalities of the neck were noted. There was no thyroid enlargement; the chest was symmetrical. There was equal expansion of both sides of the chest on inspiration. No abnormalities other than slight emphysema of the chest were found. The lungs were clear to percussion and auscultation; no râles or abnormal sounds were noted. The heart was regular in rhythm and the sounds were distant. No cardiac thrills or murmurs were noted. The blood pressure was 142/84.

The abdomen was slightly obese. A right McBurney's scar was present with a large postoperative hernia. Liver, kidney and spleen were not palpable. There was some pain on pressure just below the umbilicus and in the midline; it was believed that a mass was pres-

ent in this area. There was no muscle guard or muscle rigidity.

Except for slight enlargement of the left testicle, the genitalia were negative. On the extremities a small growth, the size and shape of a small thimble, was present on the left thigh. There were no varicosities and no edema or limitation of motion. The skin was negative. Reflexes were physiologic. Rectal examination revealed no masses or fecal impactions. The prostate was firm and slightly enlarged.

Laboratory work revealed the following: Hemoglobin, 14 Gm., 90 per cent; color index, 0.9 plus; red blood cells, 4,790,000; white blood cells, 11,200; Kahn reaction, negative; stab cells, 11 per cent; segmented cells, 79 per cent; lymphocytes, 10 per cent. Urinalysis: Color, amber; appearance, cloudy; specific gravity, 1.030; reaction, acid; protein, plus; sugar, negative; erythrocytes, occasional; leukocytes, occasional; epithelium, plus; casts, negative; crystals, negative.

The patient entered hospital on January 29, 1946 in acute distress. He apparently had an acute retention of urine. Catheterization recovered only 11 ounces of urine. Morphine sulfate was given the patient for relief of the pain. On January 30, 1946, the patient complained of acute pain in the abdomen which was localized about the umbilicus. Pain was accompanied by nausea and vomiting. Catheterization of the bladder showed no retention. The patient stated that he felt better following catheterization.

On January 30, 1946, the patient appeared to be acutely ill. Pallor was marked and the pulse was weak and thready. Blood pressure was 100/70. The patient was moaning with pain and retching. The abdomen was acutely tender to examination and there was some muscle guard and rigidity present below the umbilicus. In view of the tremendous change for the worse in the patient it was decided to convey him to the operating room for immediate surgery. Five hundred cc. of plasma was given prior to surgery. Preoperative diagnosis was intestinal obstruction, acute; postoperative diagnosis was gangrene of the entire jejunum and a large portion of the ileum due to mesenteric thrombosis caused by mass at root of mesentery.

Gross findings revealed that the entire jejunum and a large portion of the ileum were entirely gangrenous. There was a large amount of foul, putrefactive-smelling, sanguineous fluid

free within the abdominal cavity. There was a large mass at the root of the mesentery with obstruction of the blood supply to the bowel and thrombosis of the mesenteric vessels.

The entire length of the bowel involved was resected, together with its mesentery, down to the root. The resection was extended to include the bowel which appeared grossly viable and healthy. An end-to-end anastomosis was then performed using dulox suture. Five Gm. of sulfathiazole was poured into the abdominal cavity and a drain was inserted. The abdomen was then closed in layers and three figure of eight retention sutures were inserted. Clips were used for the skin.

Pathologic report revealed that the specimen consisted of 12 feet of small intestine beginning with the proximal portion of the jejunum. The entire intestine removed had a thickened wall which was dull, dark, black and soft throughout. A portion of the mesentery removed showed many purplish, firm, dried masses within the vessel walls, being perhaps more marked in the lumen of the veins. There were several irregular purplish masses throughout. In the central portion of the mesentery was an irregular unilocular cyst with a thin, shiny wall which contained brown material which was apparently feces.

Sections of the mesentery showed considerable hemorrhage with slight fibrosis and many thrombi throughout its veins. Sections of the cyst previously described as occurring in the mesentery showed a hyalinized fibrous tissue wall with some round cells and some golden-brown pigment.

*Diagnosis:* Mesenteric thrombosis with gangrene of the entire jejunum and a portion of the ileum; old, probable inflammatory cystic mass in the mesentery.

The patient returned from surgery in poor condition. Wangenstein suction apparatus was inserted; the patient was given 100,000 units of penicillin and 40,000 every three hours thereafter. The patient's postoperative course was remarkably smooth and uneventful. His highest postoperative temperature was 101.4°F. The temperature became normal on the seventh postoperative day, the clips were removed on the sixth day and the drain was removed on the eighth day. The patient's bowels moved spontaneously on the sixth day and the movements were frequent and resembled diarrhea in character. He was discharged on the

eighteenth postoperative day with no complaints other than loss of weight and diarrhea. The high caloric diet and high vitamin diet which the patient had received during his convalescence in the hospital was continued at home.

The frequent bowel movements continued in spite of administration of kaomagma, paregoric, etc., for five months, at which time they diminished in frequency and fluidity. At the present time, which is eight months after surgery, the patient has from three to five movements a day which are soft but not liquid. He has gained 20 pounds in weight and has no complaints other than the complaint of always being hungry.

#### SUMMARY

1. Prior to this report 116 successfully resected cases of mesenteric thrombosis have been reported in the literature.

2. Of the 116 cases there have been twenty-six patients with a resection of more than 200 cm., the average being 314 cm.

3. The disease is rarely diagnosed preoperatively.

4. The condition is 100 per cent fatal without surgery.

5. Surgery is indicated regardless of the apparent futility of the procedure.

6. Two additional, successfully resected cases are reported by the author; one is of a twenty-seven year old female and the other is of a sixty-one year old male, the amount of bowel resected was, respectively, 99 cm. and 366 cm. The distal portion of the small intestine was involved in the first case and the proximal portion of the small intestine was involved in the second.

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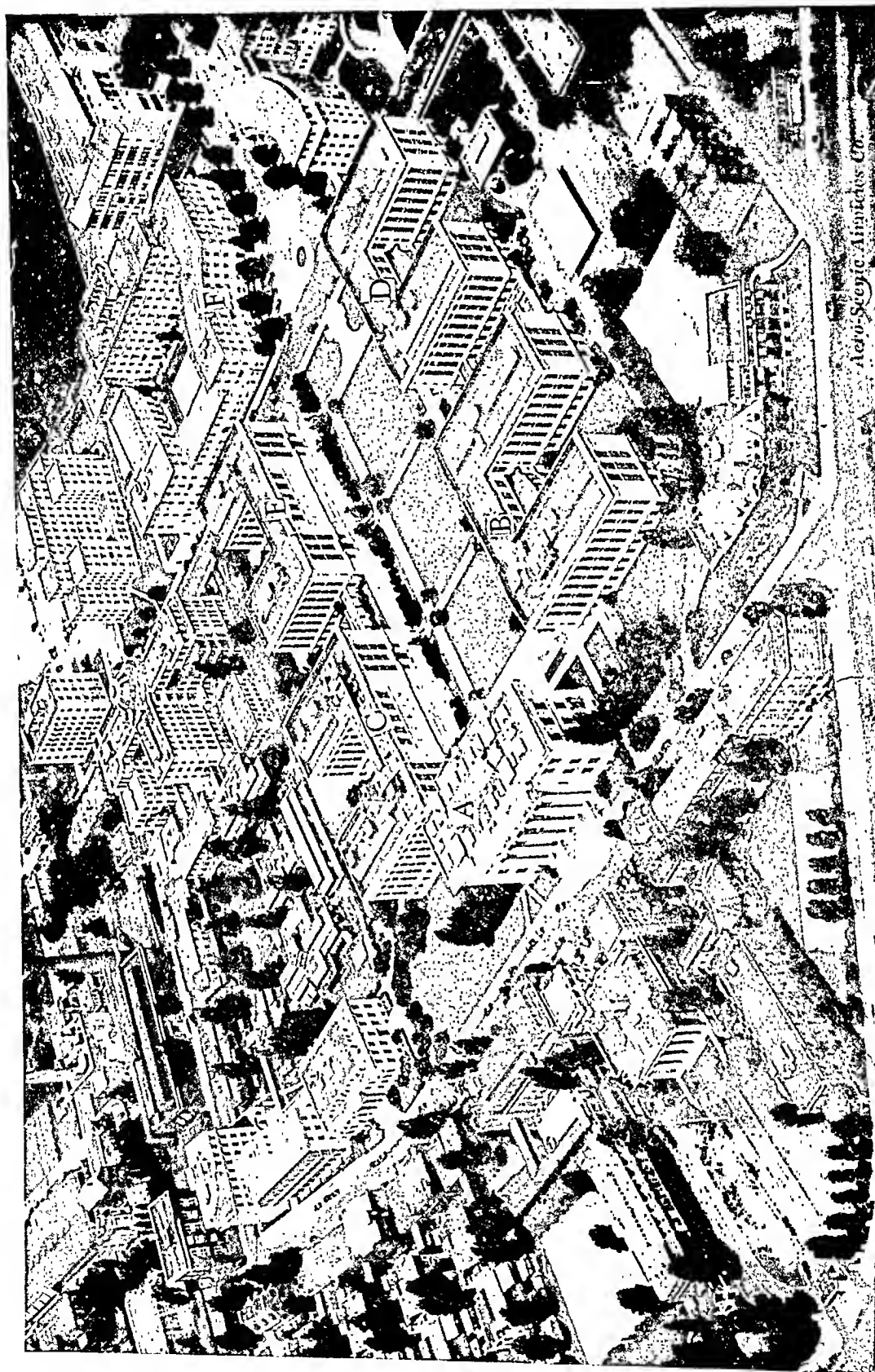
## HARVARD MEDICAL SCHOOL BOSTON

THE Harvard Medical School started as a branch of the University in 1782, when three professorships of medicine were established. The first degrees, Bachelor of Medicine, were conferred in 1788. Until 1811 the degrees of Bachelor of Medicine and Doctor of Medicine were conferred, the former on graduation from the Medical School, the latter on examination at least seven years after graduation. In 1811 the degree of Doctor of Medicine was granted to graduates of that year and to earlier graduates who had not been admitted to it, and all graduates since 1811 have received this degree. From 1911 to 1921, inclusive, the degree of Doctor of Public Health was conferred for graduate work. Since 1921 the degrees of Bachelor of Public Health, Master of Public Health and Doctor of Public Health have been conferred under the School of Public Health.

When the Medical School opened, the first lectures were given in the buildings of the College, Harvard Hall and Holden Chapel. The School moved to Boston in 1810 in order to be close to whatever hospital facilities might develop in a large and growing city, and has remained there since. In 1816 the first Medical School building was erected. From 1882 until 1906 the School occupied the building at the corner of Boylston and Exeter Streets now used by Boston University. In September, 1906, the School moved into its present buildings on Longwood Avenue and Shattuck Street. They are five in number and with their surrounding grounds occupy eleven acres. One of these is designed for administration and four for housing the laboratory departments, and for laboratory and clinical instruction. These buildings are (A) The Administration Building; (B) Departments of Anatomy, Histology and Embryology; (C) Departments of Physiology, Physical Chemistry, Biochemistry and Experimental Surgery; (D) Departments of Bacteriology, Pathology and Preventive Medicine; (E) Houses of Pharmacology, Legal Medicine, Comparative Pathology and Tropical Medicine. The clinical departments are housed in the various hospitals associated with the School. Vanderbilt Hall (F), the dormitory for medical students, is immediately adjacent to the Medical School buildings.

Previous to 1906, the major part of the clinical teaching was carried on in the Massachusetts General and Boston City Hospitals. Since that date, however, there has grown up in the neighborhood of the Medical School, and become affiliated with it, a group of hospitals which are used for clinical teaching and investigation, in addition to the clinical facilities previously at the School's disposal.





Harvard Medical School



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# New Instrument

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## A NEW CLAMP DESIGNED TO FACILITATE CLOSURE OF THE DUODENUM IN GASTRIC RESECTION\*

RAYMOND W. McNEALY, M.D. AND JACOB A. GLASSMAN, M.D.

*Chicago, Illinois*

WHEN it becomes necessary to resect a part or all of the stomach, the duodenum which remains must be closed at its proximal end in a manner that will insure against leakage or disruption. This is not always an easy task. On the contrary, it sometimes develops into a major procedure. When the operation is done for duodenal ulcer, much will depend on whether this ulcer is situated on the anterior free surface of the duodenum or on its posterior pancreatic embedded wall. Ulcers on the anterior wall of the duodenum usually lend themselves to resection in their entirety without great difficulty and with few complications. In these cases the duodenum can be mobilized and freed from its adjacent structures for a distance sufficient to admit of easy closure and inversion of the cut end.

In our group of patients we have found that this new clamp lends itself to a rapid and efficient closure. It is designed to insure easy application under direct vision and while it securely closes the proximal duodenum within the grasp of its jaws, it at the same time permits the distal cut end to slide out of its grasp without being crushed or traumatized. The insertion of a basting stitch serves to prevent the regurgitation or reflux of duodenal contents until the final closure and inversion stitches can be inserted. We are of the opinion that the duodenal stump will be more effectively sealed if the tissues which are sutured and

inverted have not been crushed. At present it is the usual custom to apply a crushing type of clamp and then invert the crushed portion of the stump by continuous or interrupted sutures. There is little doubt that healing is accomplished more quickly when the cut ends are inverted without any part of them being devitalized. Devitalized tissue must first be sloughed away before healing can take place. It is in the presence of such devitalized tissue that infection is most likely to originate. If infection does occur, it may lead to local abscess formation or even frank disruption of the duodenal stump.

Probably the greatest number of duodenal stump accidents and complications follow resection for ulcers situated on the posterior wall of the duodenum. These ulcers are frequently located in the first portion of the duodenum and frequently penetrate into the head of the pancreas. If this occurs, edema and inflammatory changes occur in and about this ulcer region, and the walls of the duodenum and the head of the pancreas become edematous, infiltrated and sometimes very friable. In attempting to resect these ulcers serious difficulty may be encountered in finding a line of cleavage between the duodenum and the pancreas. Dissections in the presence of these ulcers and their complications may jeopardize the security of the duodenal closure. The difficulty in determining the line of dissection may lead to accidental

\* From the departments of Surgery of the Cook County Hospital, Wesley Memorial Hospital, and Cook County Graduate School of Medicine, Chicago, Ill.

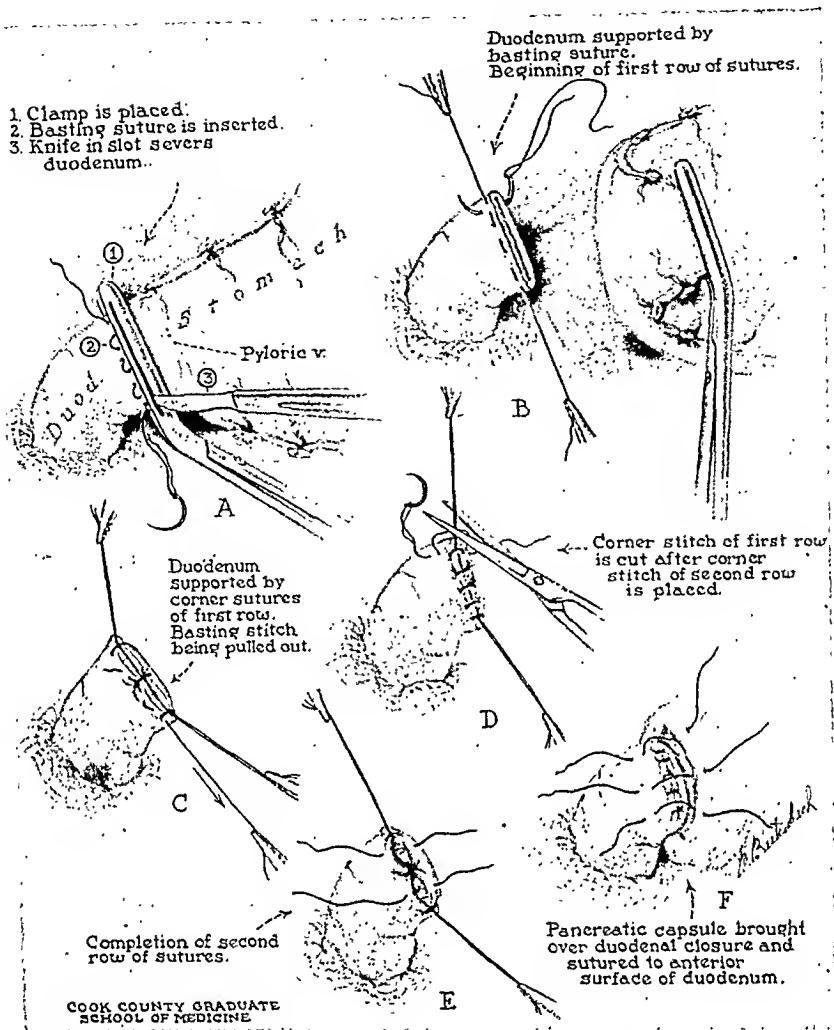


FIG. 1. Various steps in application of the non-crushing duodenal clamp.

injury or severance of the gastroduodenal artery or some of its major branches or lead to infringement on the lumen of the common bile duct. It is not within the scope of this paper to discuss the wisdom of excision of all ulcers on the posterior wall of the duodenum. If these posterior ulcers do lend themselves to resection, this new clamp will be found extremely useful. The ease of its application and the facility with which one can resect the duodenum within narrow limits and leave fresh nontraumatized edges to be accurately sutured leaves little to be desired.

Our method of closing the duodenum in resections of the stomach (Fig. 1. A to F) is as follows:

1. After the right gastric artery has been

ligated above the convexity of the duodenum and the gastroduodenal artery or its major branches ligated just below the concave border of the first portion the duodenum is then stripped gently from the head of the pancreas until there is sufficient mobility to admit application of this new clamp transversely beyond the pyloric vein.

2. A basting suture is inserted just below the clamp, but as close to its inferior margin as possible. This suture is a temporary one, used only to prevent regurgitation or reflux of duodenal contents until the final interrupted sutures can be inserted for closure and inversion.

3. When the clamp is fixed securely in position, a knife blade is inserted in the slot in the forceps and the duodenum

divided. The proximal half of the blade of the forceps holds the stomach end of the duodenum firmly in its grasp while the distal cut end of the duodenum slips easily out of the forceps' non-crushing portion and is held loosely closed by the basting suture previously mentioned.

4. The clamp and stomach are now reflected to the patient's left.

5. The first row of interrupted sutures

is now inserted to replace the basting stitch.

6. A second row of interrupted sutures is then inserted to invert and reinforce the first row.

7. As a final safeguard the capsule of the pancreas is drawn over the line of closure and attached by interrupted sutures to the anterior wall of the duodenum thus embedding the sutured end of the duodenum in the head of the pancreas.



W. J. PORTS reports a case of congenital atresia involving the transverse colon that survived and may well be the first successful case of its kind. Children born with atresia have the usual symptoms of intestinal obstruction with nausea, vomiting, obstipation, abdominal distention, etc. The site of congenital atresia is almost always distal to the papilla of the Vater, hence bile is present in the vomitus and later, unless relieved by surgery, it becomes fecal. Flat plate of abdomen is most helpful in diagnosis; barium by mouth is unnecessary and is often very dangerous. The usual surgical technique is a short-circuiting anastomosis, joining the sides of the bowel distal and proximal to the site of the atresia in an isoperistaltic manner. Actual resection of the stenosed bowel is unnecessary and prolongs the surgery and shock. These newborns, needless to say, cannot easily withstand prolonged surgical maneuvers. (*Richard A. Leonardo, M.D.*)

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# The American Journal of Surgery

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A PRACTICAL JOURNAL BUILT ON MERIT

Fifty-seventh Year of Publication

VOL. LXXVI

OCTOBER, 1948

NUMBER FOUR

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## Editorials

### MODERN SURGICAL MANAGEMENT OF NEOPLASMS OF THE HEAD AND NECK

THIS editorial deals with tumors of the face, lips, oral cavity and accessory sinuses, and primary and metastatic tumors in the neck. It does not include tumors of the central nervous system which belong to a separate specialty.

Surgery of these diseases has improved continually but there is much left to be desired by way of treatment. Thirty years ago the advent of x-ray and radium therapy into the realm of neoplastic diseases gave the medical world high hopes for greatly increased percentages of cures of cancers of the head and neck. These hopes have been realized only partially. There are many malignant tumors which until recently have been totally inoperable because of location, *i.e.*, pharynx and tonsil, and others because of the extent to which they have grown before the patient sought medical advice. Fortunately some of these are palliated and a few survive the five-year period with adequate irradiation. Other cancers of the face, lips and anterior part of the tongue are frequently eradicated by radium or x-ray therapy with little mutilation.

However, radiology does fall short of the anticipated percentage of cure. Those tumors which are radioresistant but shrink greatly with irradiation are often removed surgically. Other cancers require so much

therapeutic irradiation that immediate or late sequellae develop as radio-osteonecrosis, early or late, and sloughing of the scar in the mouth subsequent to secondary infection (sore throat or infected tooth). Surgical removal of the irradiated area or the necrotic bone, therefore, becomes imperative sooner or later. It is quite obvious then that in many cases irradiation and surgery are combined in order to eradicate the disease and to shorten the period of convalescence, or to hasten the repair of damage brought on by the necessarily heavy irradiation required to destroy the cancer. Fortunately in recent years there have been certain advances in surgical technic which have made it possible to perform extensive operations about the head and neck that twenty or thirty years ago were unheard of or, if tried, were associated with high surgical mortality. These improvements fall into six important classes:

Preoperative *irradiation* of malignancies about the oral cavity and accessory sinuses has the following advantages: (1) If the cancer is radiosensitive, it might be possible to eradicate it completely and avoid operation. (2) If moderately radiosensitive, the growth will be greatly reduced in size and its vitality diminished, making operative removal easier and safer. The cancer is

surrounded by dense scar tissue thus walling off the local growth and metastases in the neck so that the operation can be performed without encountering active viable tumor cells. It is true that preoperative irradiation increases the vascularity of the tissues and often obliterates fascial planes. Some authorities claim that this increases the difficulty of operation. However, such difficulties are far outweighed by the increased safety of operation and reduced size of the tumor. Also, the electrosurgical technic offsets the increased vascularity.

*Anesthesia* which about a hundred years ago greatly enlarged the fields of surgery has in recent years taken on new developments. The administration of inhalation anesthesia has always been difficult with patients undergoing operations about the head, particularly the face and mouth. The use of pentothal sodium intravenously has given the surgeon freedom from annoying anesthetic apparatus about the head. Intratracheal anesthesia also has increased the efficiency of modern anesthetics and has given the anesthetist an opportunity to control gases and air inhaled and exhaled. Intratracheal anesthesia also permits adequate packing of the nasopharynx and hypopharynx with gauze to prevent the aspiration of blood, particles of tissue, bone or teeth which would cause postoperative pneumonia, lung abscesses, etc., complications which formerly were common following oral operations.

One of the great dangers in surgery of the head and neck in former years was secondary infection, both local and through extension into the neck and lungs, as well as systemic infection. Modern *antibiotics* such as sulfa drugs and penicillin eliminate postoperative infection in the operative field, chest or blood stream almost completely.

Because of the vascularity of the tissues about the oral cavity the hemostatic properties of *electrosurgery* are now indispensable in hemiglossectomy or the safe removal of large neoplasms in the mouth and pharynx. The small opera-

tive space in the mouth does not allow the application of a large number of hemostats. Consequently, any technic which limits the amount of instruments required in the mouth greatly facilitates operative procedures.

Electrosurgical cutting currents also facilitate the dissection of adherent tumors of the neck, particularly metastatic glands, which have been given heavy irradiation preoperatively. The clamp coagulation method of hemostasis makes it possible to control hemorrhage from vessels which often cannot be tied. This technic enhances the completion of hemostases when large numbers of hemostats are placed upon blood vessels in the skin and fascia in the neck.

In previous years satisfactory postoperative *nutrition* was difficult to maintain following extensive operations upon the mouth, tongue, lip or jaw. Many patients actually starved to death for lack of proper food. Modern knowledge of nutritional needs of vitamins, minerals, electrolytes, as well as proteins, fats and carbohydrate intake makes it possible to keep the patients on a perfectly normal food intake even though they are unable to swallow. Adequate fluids and foods are given either through intranasal tube or by gastrostomy. The latter has been rarely necessary in our practice as most patients can be fed adequately by the intranasal route.

With the marked advances in *plastic surgery* it is now possible to remove extensive growths from the head and neck, including portions of the jaws, with the expectation of restoring the patient to fairly normal function. Some times these plastic procedures are performed at the time the neoplasm is removed. In other cases the plastic procedures are delayed until there is reasonable assurance that the cancer will not return, or until the tissues are ready to receive skin flaps from other portions of the body. Frequently it is impossible to replace all the bone and soft tissues that have been removed, such as

the hard palate or superior maxilla. *Prostheses*, often carrying teeth, make it possible for a patient to swallow and talk practically normally. Frequently these prosthetic appliances are used also to replace part of the lower jaw or an eye. Not uncommonly temporary prostheses are made prior to operation for insertion in the mouth at operation to maintain jaw position for a week or ten days postoperatively allowing the patient to swallow and talk

normally. In this way he is relieved of the necessity of prolonged intranasal feedings until healing is complete when he is fitted with a permanent appliance. The hope of plastic reconstruction or the adaptation of a proper prosthesis gives the surgeon courage to perform and the patient courage to undergo what a few years ago were almost unheard of operations.

GRANT E. WARD, M.D.



McCLURE and Lam studied over 150 cases of cancer of the lip or face and found that prophylactic dissection of non-palpable lymph nodes of the neck does not apparently improve the prognosis of these patients. Of course, all palpable, enlarged nodes and all regional lymph nodes should be removed, if possible, at the same time that the primary malignant lesion is excised; but in early cases of lip cancer, radiation of the lymphatic areas may suffice. In many cases the only indicated treatment is careful observation. If and when the cervical glands become palpable, excision, radiation or both are indicated. (*Richard A. Leonardo, M.D.*)

## HYDATIDIFORM MOLE AND CHORIONEPITHELIOMA

**H**YDATIDIFORM mole is a relatively rare condition, its incidence being approximately 1 in 2,000 pregnancies. Chorionepithelioma, however, is exceedingly rare, and there are even many large clinics in which not a single case has been encountered. Moreover, if one looks over the cases reported in the literature, it is quite evident that in many of these there have been errors of interpretation, and that a not inconsiderable proportion were instances of benign although perhaps proliferative types of hydatidiform mole.

As a matter of fact there is no field of pathology in which mistakes in diagnosis are more common than in this, and such errors have all too often led to unnecessarily radical plans of treatment. General pathologists have little opportunity of familiarizing themselves with the characteristics of such a rare lesion as chorionepithelioma as well as its differentiation from benign hydatidiform mole. Further elements of confusion have been added in recent years through overemphasis on the diagnostic and prognostic significance of the biologic tests which, valuable though they are, should be looked upon only as adjuvants to the clinical evaluation of such problems.

While the frankly benign and the frankly malignant cases offer no difficulty in microscopic differentiation, there is a borderline group in which there will be uncertainty in the minds of even highly trained and experienced gynecological pathologists. To this intermediate group have been applied such designations as malignant mole or chorio-adenoma destruens. Efforts at correlating the histologic and clinical characteristics of such moles, chiefly on the degree of trophoblastic proliferation or on the degree of apparent anaplastic activity, have thus far not been satisfactory; this includes the recent classification suggested by Hertig.

The difficulty lies in the fact that even a normal trophoblast exhibits many of the characteristics commonly associated with malignancy. It destroys and invades the maternal tissues, it penetrates the blood vessels and it even undergoes a species of normal or physiologic metastasis as can be seen in the process of deportation of trophoblastic masses and villi to the lungs; this probably occurs in all normal pregnancies.

However, the maternal tissues, presumably through the agency of the decidual cells, exhibit a defensive mechanism which holds the trophoblastic encroachment within normal limits. A deficiency in this defensive mechanism may be more important than abnormal trophoblastic activity in the explanation of the abnormal vascular penetration which characterizes the so-called malignant mole or chorio-adenoma destruens. On the other hand, it is quite likely that it is this defense mechanism, the nature of which we do not know, that explains the spontaneous local regression and even complete cures which have been reported in occasional cases of genuine chorionepithelioma.

There is now general appreciation of the fact that a high quantitative gonadotrophic titer is not by any means of decisive diagnostic importance, chiefly because this diagnostic problem usually arises at that phase of pregnancy in which there is normally a high peak of gonadotrophin production, and this may at times be just as high or higher than that seen in some cases of hydatidiform mole. Much more important is the biologic follow-up after evacuation of the mole although this, too, offers possible pitfalls.

The persistence of a high titer is suggestive, but not by any means does it necessarily point to malignancy in the form of chorionepithelioma. Before thinking of radical measures it is always better to do

a repeat curettage, especially as this generally can be carried out more safely and thoroughly now that the uterus is smaller and firmer. Often the curettage will reveal further molar tissue, but sometimes not. In either case if a high or increasing titer persists beyond this, one is fully justified in proceeding with hysterectomy.

This may reveal a definite chorionepithelioma but in most cases it will not. More often microscopic examination of the removed uterus reveals that the high gonadotrophic titer has been due to trophoblastic tissue, often with large molar villi, deep in the uterine wall and sinuses. Such rests are inaccessible to the curette. However, the hazard in such cases is so great that the radical procedure is fully justified. Furthermore, there is always the possibility that such trophoblastic rests may give rise to later intramural chorionepithelioma. I need not emphasize the importance of other diagnostic procedures, especially roentgen examination of the chest, nor need I elaborate on certain vagaries of the biologic test, such as the completely negative

phases seen in the occasional case of chorionepithelioma.

These random comments are set forth merely to call attention to the many problems still surrounding this general subject along pathologic, diagnostic and therapeutic lines. It was for this reason that one of our national organizations, the American Association of Obstetricians, Gynecologists and Abdominal Surgeons, recently created the Albert Mathieu Chorionepithelioma Registry which was announced in the *American Journal of Obstetrics and Gynecology* and a number of other medical publications. The accumulation, study and follow-up of the cases submitted to this registry should in time yield worth while results in the elucidation of some of the problems which have just been indicated. It is sincerely hoped also that gynecologists and obstetricians throughout the country will join in this cooperative undertaking by sending to the registry material and clinical data from cases of hydatidiform mole and chorionepithelioma from their own practices and clinics.

EMIL NOVAK, M.D.





# Original Articles

## CLEAVAGE PLANES IN RECONSTRUCTIVE VAGINAL PLASTIC SURGERY\*

J. V. RICCI, M.D., C. H. THOM, M.D. AND W. L. KRON, M.D.

New York, New York

**A** RECOGNITION of the basic relationships between the fibromuscular elastic wall of the vagina as a central organ and the juxtaposed urethra, bladder, cervix, rectum, anoperineal body and cul-de-sac peritoneum is indispensable

These basic relationships are clear: (1) There is a complete fusion between the anterior vaginal wall and that of the urethra throughout its entire length. Because of this fusion, surgical separation of these two structures can be accomplished only by blunt dissection and this leads to an unavoidable ooze. (2) There is a clear-cut line of separation, an areolar cleavage plane, between the anterior vaginal wall and the juxtaposed bladder wall from the urethrovesical area to the point of fusion of the vagina and the cervix. This areolar cleavage plane extends beyond this point and separates the bladder wall from the cervicofundal surface up to the vesico-uterine peritoneal reflection. These definite lines of separation, or areolar cleavage planes, lead to a bloodless separation of the bladder from the vaginal wall and from the cervicofundal surface. (3) There is a complete fusion of the posterior vaginal wall with the short perineo-anal body. Separation of these structures which can be accomplished only by blunt dissection leads to an unavoidable ooze. (4) There is a clear-cut line of separation, an areolar cleavage plane, between the posterior wall of the vagina and the wall of the rectum, extending from the anorectal area to the cul-de-sac peritoneal reflections. (Fig. 1.) The presence of this areolar cleavage plane permits a bloodless separation of these two organs. *But in no instance does a surgically useful fascia line or encase the vagina or any of the juxtaposed organs.*

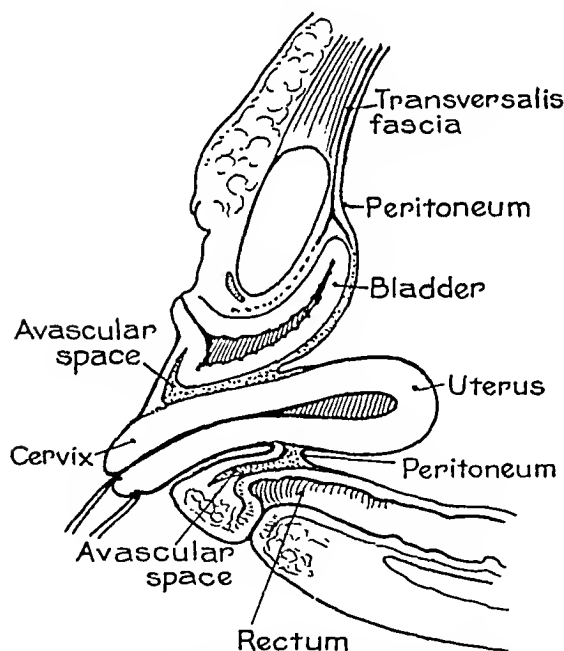


FIG. 1. Diagram of the elongated prolapsed cervix under tension. The anterior stippled area indicates the cleavage plane which separates the bladder from the vaginal wall and cervical surface. This anterior cleavage plane or space is avascular and loosely packed with areolar tissue. The posterior stippled area indicates the cleavage plane between the vaginal wall and rectal wall and cul-de-sac peritoneum.

in reconstructive vaginal surgery. The vagina as a *point d'appui* is directly involved in surgery for relaxations, lacerations, fistulous formations and descent of the urethrovesico-anorecto-genital parts.

\* From the Department of Gynecology, City Hospital, New York, N. Y.

wall meets and fuses with the cervix at an obtuse angle, the degree of angulation increasing proportionately to the amount of retrodisplacement of the normally posed uterus. In the presence of a prolapsed, elongated cervix the vaginal wall meets and fuses with the cervix at an acute angle. At the apex of this angle, the bladder wall, instead of coming to a sharp point, circles away from this vaginocervical angulation, thus creating a clear space or blind pocket thinly packed with scattered areolar fibers. A similar blind pocket in both the normal and prolapsed state exists between the cul-de-sac peritoneum as it swings cephalad to cover the rectosigmoid and the posterior vaginal wall as it swings pedad from its point of fusion with the posterior cervix. This pocket is packed with a loosely felted areolar mesh. A knowledge of these relationships and utilization of precise methods of approach to avascular spaces and cleavage planes shortens operating time, minimizes bleeding and, in brief, simplifies vaginal plastic surgery.

#### HISTORICAL BACKGROUND

Vague recognition of a cleavage plane and also of cellular tissue between the bladder and the cervicofundal surface was apparent in the description of a vaginal hysterectomy for a carcinomatous uterus by J. N. Sauter<sup>1</sup> in 1822. He made a circular incision around the cervix, separated the vaginal cuff from the cervical substance, introduced two fingers into the opening and "tore" the cellular tissue. J. C. A. Récamier,<sup>2</sup> operating for a similar lesion in 1829, made a transverse incision from right to left over the vaginal wall as it fused with the cervical substance and "pushed aside" the cellular tissue which "united" the vagina and the bladder with the surface of the uterus. These intrepid operators were dealing with a cleavage plane between the bladder and the cervicofundal surface, rather than the plane between bladder and vaginal wall. Although he did not set out to do so, the first actually to expose the cleavage plane between the vaginal wall and the bladder was J. Marion Sims<sup>3</sup> (1856). He had to obtain permission from the consulting board of The Woman's Hospital in the State of New York to excise

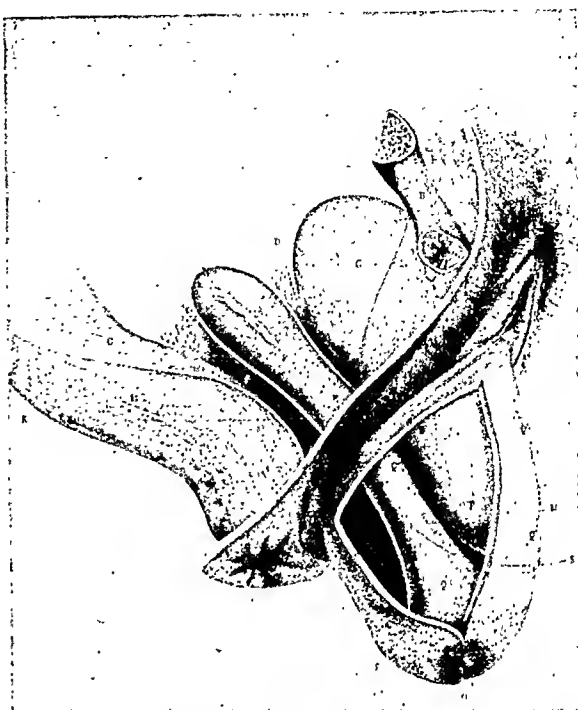


FIG. 2. Semidiagrammatic view of prolapse of the elongated cervix. The creation of a triangular window by excising the lateral vaginal wall area shows the contour of the distended bladder at the cervicovaginal point of fusion. Noticeable also is the lack of any connection of the bladder to the cervix and vaginal wall. The small dark area between bladder and the cervicovaginal fusion point is the anterior avascular areolar space. Below the elongated cervix appears the posterior avascular areolar space. (From P. C. HUGUIER. *Mém. Acad. Imp. de med.*, vol. 23, plate II, 1859.)

the sagging anterior vaginal wall and the base of the bladder in a woman of thirty with an "enormous cystocele." With the patient in the left lateral position Sims hooked the center of the sagging wall, held it under tension and placed a crescentic-shaped clamp at the base of the bulge. This clamp made especially for the purpose resembled Ricord's phimosis clamp. He cut the redundant tissue below the clamp but, contrary to expectation, noted that he had removed the hypertrophied vaginal wall, entered a clear-cut cleavage plane and left the bladder wall intact. Believing that hemorrhage and abscess formation might result, Sims considered this method of removing a sacculated portion of the vaginal wall too formidable. The existence of cleavage planes between the vaginal wall and the bladder and between the bladder and the cervicofundal surface was clearly noted by P. C. Huguier<sup>4</sup> (1859) who grasped the redundant vaginal wall (cysto-

cele) and passed four pins through the cellular tissue between the vaginal wall and the base of the bladder. To avoid injury to the bladder he passed his little finger into that viscus through a dilated urethra to act as a guide. (Fig. 2.)

Accompanying Huguier's lengthy article is the first accurate portrayal of the relationship of the bladder to the elongated cervix and vaginal wall in prolapse and cystocele. This remarkable semidiagrammatic portrayal, according to Huguier, was based on a presentation by J. Cloquet.<sup>5</sup> In 1872 T. Gaillard Thomas<sup>6</sup> described his method of narrowing the vagina and, in addition, gave details of the operative minutiae involved in entering the cleavage plane between the vaginal wall and the bladder. Thomas was the first gynecologist to use the term *loose areolar tissue* though *areolar* was commonly used by anatomists. Furthermore, he specifically stated that he removed the entire thickness of the vaginal wall. A. Farre,<sup>7</sup> anatomist and lecturer in obstetrics, stated in 1859 that the anterior vaginal wall was connected with the urethra and the base of the bladder by areolar tissue. To facilitate separation of the anterior vaginal wall from the juxtaposed bladder, Gaillard Thomas invented a special instrument on the principle of the glove stretcher. Neither S. Choppin<sup>8</sup> (1861) of New Orleans, who performed the first vaginal hysterectomy for prolapse, nor A. Patterson<sup>9</sup> (1876) of Glasgow, who performed the second operation of this kind, mentioned any cleavage planes in the brief descriptions of their respective technics. The first to advise lifting the entire thickness of the vaginal wall from the cervix in the repair of a cystocele was B. E. Hadra<sup>10</sup> of Texas in 1888. G. Winter<sup>11</sup> in discussing the pathology of prolapse proposed detaching the bladder from the vaginal wall by making an oval incision over the anterior vaginal wall (1896). R. Gersunny<sup>12</sup> in 1897 stated that in cases of cystocele he made a median incision through the anterior wall of the vagina, beginning from the anterior lip of the os uteri and reaching into the bulbus urethrae. This enabled him to detach the anterior vaginal wall from the bladder. Max Sänger<sup>13</sup> in his discussion of this subject called attention to the fact that he had advised detaching the bladder from the vaginal wall in 1892 and had reported his views before the International Congress of Gynecologists at Brussels.

H. F. Kreutzmann<sup>14</sup> considered it essential to free the bladder from the uterus as well as from the vagina by a median incision (1900). He had originally made this communication before the California Academy of Medicine in 1895. Equally clear is I. S. Stone's<sup>15</sup> statement that the bladder has a thin layer of cellular tissue between its posterior and inferior surfaces and that this cellular tissue makes it possible for the operator to separate the bladder from its attachments. In 1902 Kreutzmann<sup>16</sup> reiterated his views on the cellular separation between vaginal wall and bladder. The abandonment of denudation operations led to the popular method of "insinuating" a scissors from the cervix to the urethral orifice in order to separate the "mucosal flaps" from the vaginal wall and thus expose the fascia (the inverted T incision). Obviously, this incision merely split the anterior vaginal wall leaving the outer layer of fibromuscular elastic tissue on the mucosal side of the vagina and the inner layer on the bladder musculature. On this point Bissell<sup>17</sup> said that the common method of approach (by longitudinal incision through the anterior vaginal wall from a point near the "base of the urethra" to a point near the junction of the vaginal wall and the cervix) followed artificial lines of dissection and did not lead with any degree of precision into the cleavage plane (1930).

The first to abandon the haphazard methods of separating vaginal wall from rectal wall was D. Bissell<sup>18</sup> who began to expose the "natural" rectovaginal cleavage planes (his cellular arca) in 1918. About 1924 Bissell began to expose the "natural" cleavage plane between the vagina and bladder by elevating the anterior vaginal wall just above its cervical incision and incising its entire thickness, thus exposing the cellular space between the bladder and the cervicofundal surface. In 1928 B. H. Goff<sup>19</sup> featured this procedure in his article on repair of the damaged pelvic floor. In 1930 R. A. Hurd<sup>20</sup> stated before the New York Obstetrical Society that Bissell had demonstrated to him an approach to the "clear space" between the vaginal and the bladder walls, which approach could not be too warmly advocated because of its simplicity and its comparative freedom from "liability of bladder injury." In the discussion following Hurd's article Bissell referred to his own method of reaching the line of cleavage and added that he was convinced that there

was no definite fascial layer which could be isolated and utilized for surgical purposes. E. Hesketh Roberts<sup>21</sup> in 1931 described and depicted diagrammatically his method of approach to what he called the layer of loose intervisceral avascular tissue in the avascular space. In 1933 the Bissell method of exposing the vesicovaginal cleavage plane was described by Goff<sup>22</sup> and realistically portrayed by E. M. Freret.

According to R. H. Paramore,<sup>23</sup> Th. Addis Emmet in 1871 first began to believe that the pelvic fascia could be used to support the uterus. By 1883 he had come to attach greater importance to the fascia, thinking that it could also be used to support the posterior vaginal wall. Emmet<sup>24</sup> was the first to mention the fascia as an essential factor in vaginal plastic surgery in his address to the members of the American Gynecological Society in 1883. This novel idea elicited harsh and caustic comment in the discussion to his article.

A search for a supportive visceral pelvic fascia through the years has rendered vaginal reconstructive surgery inconclusive and has generated an excess of anatomic terms and a medley of operative technics. Vaginal plastic surgery has been seriously hampered by the assumption that supportive fascial molds encase and hold the bladder, the vagina, the urethra and the rectum in place; that a cystocele, a urethrocele and rectocele are hernias through rents in the vesicovaginal, urethrovaginal and rectovaginal fascias. These are misconceptions. Considering the differences in anatomic relationships between the vagina and the urethra and between the vagina and the bladder—the marked fixation of the urethra to both the pubic arch and the vaginal wall and the complete separation of the bladder from all surrounding structures—it is highly doubtful that such an entity as a urethrocele can occur. Nothing has been more pernicious in vaginal plastic surgery than the flap-splitting of the vaginal wall which has led to the creation of a fascia; nor the plunging or “insinuating” of closed scissors into the substance of the vaginal wall which has, in most instances, led to the creation of false

planes, leaving part of the vaginal wall either on the bladder or on the rectum. Pernicious is the use of “gauzed finger” displacement of an organ, almost always an indication that the operator is not in the right plane and is anatomically lost. Equally misleading is the introduction of a sound into the bladder to locate its lowermost wall. The bladder is a movable organ and the tip of the instrument can displace it down to the very point of fusion between the vaginal wall and the cervix.

Vaginal plastic surgery is reconstructive surgery, demanding neatness, accuracy and symmetry in its execution. No reconstruction of the genital parts is possible without an initial “destructive” operative phase. This entails incising and excising of tissues, exposing and displacing of organs and it is in the execution of this phase of plastic surgery that serious blood loss may occur unless the natural cleavage planes are utilized. An appropriate position of the patient, best suited to display the lesion and to facilitate the operation, is essential. The sterile drapery must be so arranged as to remain securely in place throughout the operation. Suitable specula and the lateral suturing of the labia minora will add to the proper exposure. The comfort of both the surgeon and his assistants is essential since vaginal plastic procedures are tedious and frequently extended into the second operative hour. Precision in minor details adds to better end results. Each assistant must be schooled in his appointed task. A bloody operative field, strewn with bits of tissue, cluttered with useless clamps and littered with dangling unnecessary sutures displays surgical clumsiness, leads to confusion and prolongs operative time.

The technics to be described are applicable in cases presenting a descensus of the elongated cervix with or without a cystocele and in cases with a lacerated or relaxed perineum with or without a rectocele. In instances of normally posed cervix and anterior vaginal wall, approach to the cleavage plane may easily be gained by bisecting the anterior lip of the cervix

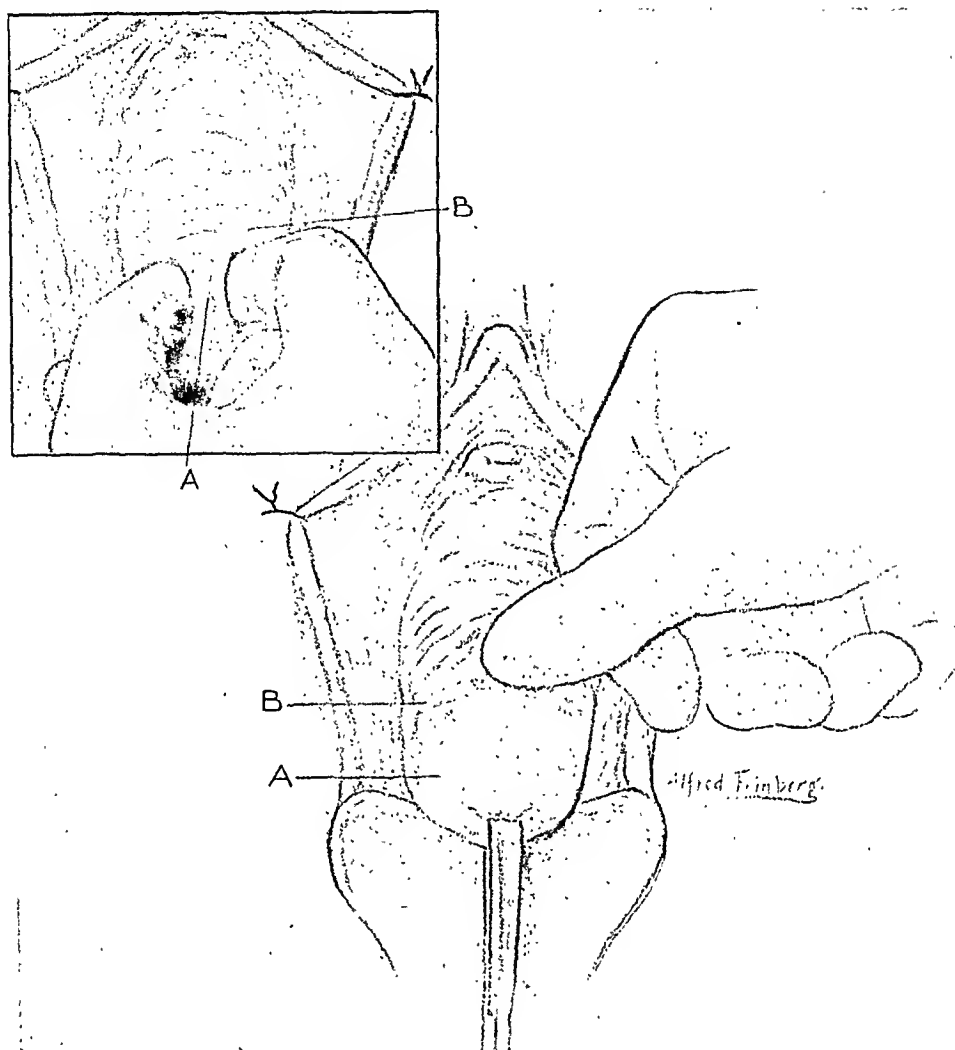


FIG. 3. The smooth surface (A) indicates portion of the vaginal wall completely fused with the cervix. The area marked (B) showing vaginal rugae indicates beginning of cleavage plane which separates the vaginal wall from the anterior surface of the cervix. This wall is massaged upward toward the urethra with swings of the thumb. *Insert:* The entire thickness of the vaginal wall above the area is grasped with fingers and elevated. This area is rubbed between fingers to "increase" separation.

and the vaginal wall exactly in midline up to the internal os. That is best accomplished by using a straight scissors and inserting one blade of the scissors into the cervical canal.

#### TECHNIQUES

*Method of Approach to the Avascular Areolar Cleavage Plane between the Anterior Vaginal Wall and the Bladder Wall and between the Bladder Wall and the Cervicofundal Surface up to the Vesico-uterine Peritoneal Fold.* The anterior vaginal wall

is placed on tension by applying traction to the cervix. This is best done by grasping both lips of the cervix with short tenacula exactly in midline. That part of the anterior vaginal wall close to the cervix is gently rolled between the index finger and thumb several times. The wall is then massaged upwards toward the urethra with "swings" of the thumb. (Fig. 3.) These initial steps are not essential although their habitual use has convinced the authors that the planes of separation thereby become more apparent. On

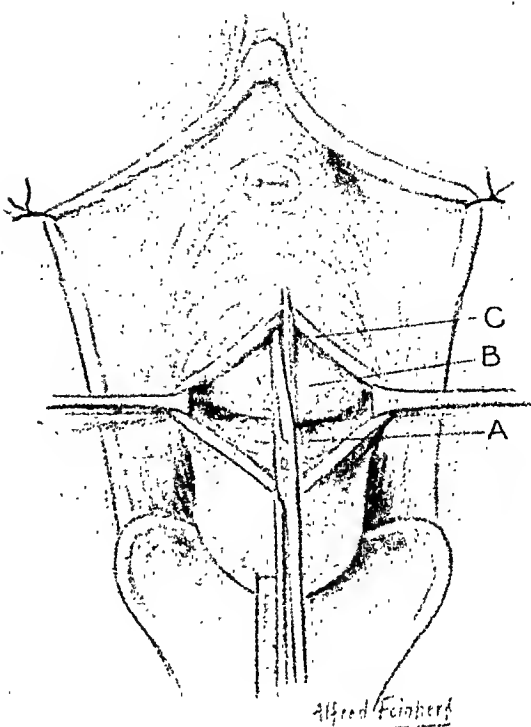
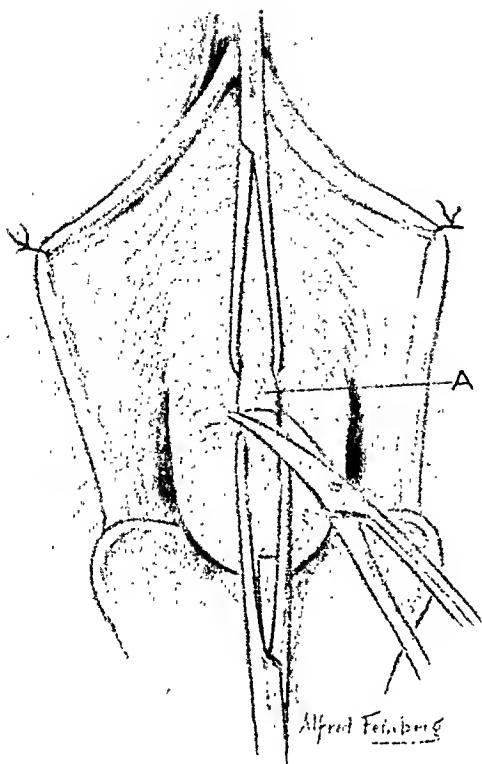


FIG. 4. The doubled thickness of the entire vaginal wall is grasped between two Allis clamps and held taut; it is cut transversely with one stroke of the scissors. This incision properly executed at the proper level leads directly into the anterior avascular space or cleavage plane.

FIG. 5. Exposure of the avascular areolar cleavage plane or space. At mid-point of the initial transverse incision of the entire thickness of the vaginal wall a longitudinal incision is begun and continued upward again including the entire thickness of vaginal wall. This incision ends at the point of fusion between vagina and urethra. A, indicates surface of the cervix; B, indicates free bladder musculature; C, indicates the entire thickness of vaginal wall.

close inspection it is possible to note where the fusion between the vaginal wall and the cervix ends and the avascular space begins. The fused portion of the vaginal wall is smooth and lacking in rugae. At this point, which is usually about  $\frac{3}{4}$  inch above the external orifice of the cervix, the vaginal wall is grasped. As a matter of fact, the clamp grasps the reduplicated layers of the entire thickness of the vaginal wall. (Fig. 4.) Another clamp is placed  $\frac{1}{4}$  inch above this first clamp. Between these two clamps the entire thickness of the vaginal wall is incised with a curved scissors, the tip of the scissors pointing perpendicular to the cervix. If this incision is made at the correct level, an avascular clear space (Fig. 5) or pocket-like compart-

ment appears, bringing into view the lowermost tip of the bladder and a few shreds of areolar fiber. The bladder can be displaced instantly from the vaginal wall and from the cervicofundal surface without effort and without loss of blood by introducing the index finger into this pocket. The bladder separation ends at the urethro-vesical junction and at the vesico-uterine peritoneal fold. It is essential to incise the entire thickness of the vaginal wall and to enter the proper cleavage area. By this procedure such artefacts as pillars of the bladder, pubocervical ligaments, pubocervical fascia and uterovesical ligaments will not be "created" to plague the operator. If the tip of the bladder is not visible and if the index finger does not displace the

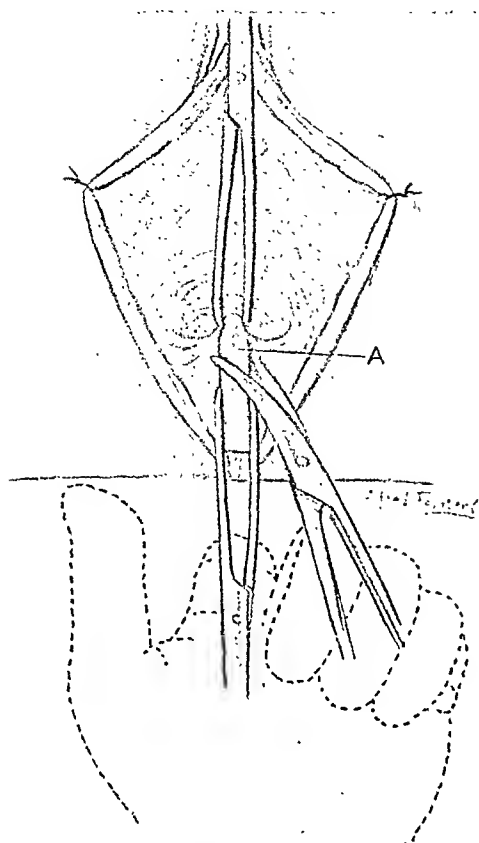


FIG. 6. The posterior vaginal wall at its point of fusion with the anoperineal body is grasped with two Allis clamps and elevated. The index finger is inserted in rectum for added guidance and safety. A transverse incision is made through the entire thickness of the vaginal wall. At point marked (A) there is no cleavage plane.

bladder instantly at the slightest pressure from the surface of the vaginal wall and the cervicofundal surface, the operator has incised too close to the cervix and has missed the avascular space. To gain the space from this point, it is best to grasp the cut surface of the vaginal wall at both ends of the incision with Allis clamps. These instruments are held taut and parallel with the floor. With a straight scissors the presenting cut margin of the vaginal wall is incised exactly in midline. This procedure will lead the operator into the avascular areolar cleavage plane. The incision is then continued up to the urethrovaginal junction where the cleavage plane ends. To go beyond this wall may injure the sphincteric urinary control.

#### *Method of Approach to the Avascular*

*Areolar Cleavage Plane between the Posterior Vaginal Wall and the Wall of the Rectum.* In dealing with this area it must be recognized that there is complete fusion between the posterior vaginal wall and the anal wall—the perineal body; and on that account, a blunt separation of the vaginal wall from the anal wall must be completed before the rectovaginal plane of separation can be reached. Landmarks are essential in the description and depiction of surgical technics but unfortunately on the vaginoperineal body they may be difficult to locate owing to the irregularities of obstetrical trauma. The essential landmarks in this instance are the hymenal ring, particularly the last hymenal caruncle, the fossa navicularis and the fourchette. Even in a markedly relaxed perineal body with no break nor scar in the mucocutaneous area these landmarks are visible; but in a perineal body scarred by a laceration or by a mediolateral episiotomy these landmarks are either none too clear or even completely effaced.

With the patient in the lithotomy position the index finger of the left hand is introduced into the rectum; a towel is clamped above the anal opening for aseptic precautions. The purpose of this finger is to follow the tip of the scissors as it nibbles away at the vaginal wall fused to the perineal body. (Fig. 6.) One Allis clamp grasps the vaginal wall just above the mucocutaneous junction and another is placed a  $\frac{1}{4}$  inch above it. With a curved scissors pointing almost perpendicular to the anal canal the vaginal wall is cut transversely. The two clamps are removed and both ends of the incision are grasped, including in the bite the ever present bleeding points. This initial transverse incision, since it is made in the perineo-anal area, will not expose the avascular areolar rectovaginal plane. The cut surface of the vaginal wall is held taut by pulling the two lateral clamps parallel to the floor. With a straight scissors pointing exactly in midline and using the urethral orifice as a guide, the vaginal wall is nibbled. Every  $\frac{1}{4}$  inch of incised vaginal wall is grasped with

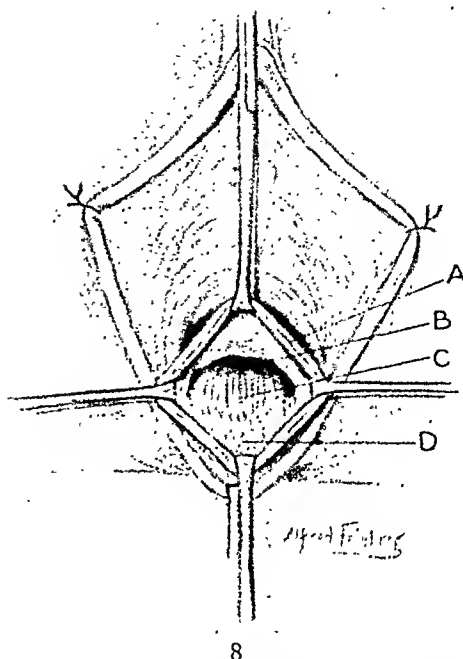
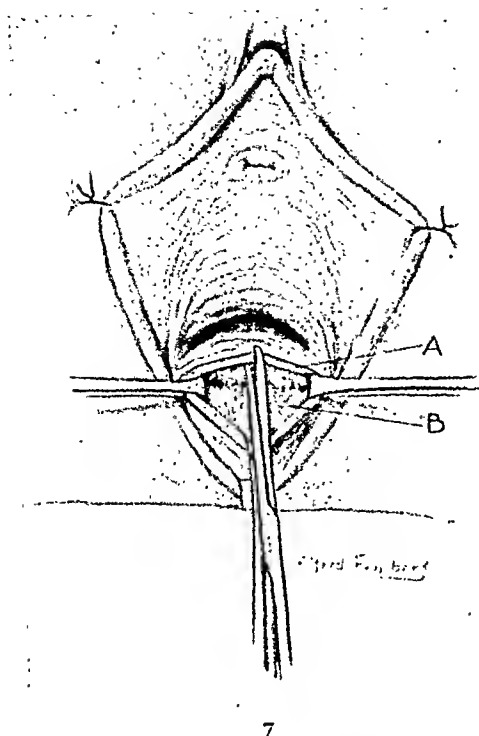


FIG. 7. At mid-point of the initial transverse incision a longitudinal incision is begun and continued upward including the entire thickness of the vaginal wall until the posterior avascular areolar cleavage plane or space is reached. A, indicates entire thickness of vaginal wall; B, indicates anoperineal body.

FIG. 8. Exposed posterior avascular areolar cleavage plane or space. A, entire thickness of vaginal wall; B and C, muscular fibers of the rectum; D, anoperineal body.

Allis clamps the better to expose the surface and to control bleeding. The nibbling process is continued until the anoperineal body is completely dissected from the vaginal wall; and at the anorectal junction a clear-cut avascular areolar packed cleavage plane is reached. (Figs. 7 and 8.) At this point with one stroke of the finger the entire rectal wall is completely separated from the posterior vaginal wall up to the peritoneal reflections. This technic will give the clearest macroscopic evidence that a rectovaginal fascia or musculofascial sheath does not exist in this area.

It is possible to make the initial transverse incision of the posterior vaginal wall just above the anoperineal area. This will make nibbling unnecessary, avoid some bleeding and will lead directly into the avascular rectovaginal cleavage plane. Denudation of the mucocutaneous area may be reserved for the second step. But in this technic care must be taken to avoid undue shortening of the posterior vaginal wall.

*Method of Approach to the Cul-de-sac Peritoneum.* The posterior lip of the cervix is grasped with a tenaculum and the cervix pulled upward and outward. A noticeable dimple marks the beginning of the avascular areolar cleavage plane and the point of fusion of the vaginal wall with the cervical substance. (Figs. 9 and 10.) At this point the entire thickness of vaginal wall is grasped by an Allis clamp. One-quarter inch below another clamp is applied and between the two a curved scissors with the curvature pointing upward away from the rectum is used to cut the entire thickness of the vaginal wall. These two clamps are removed and the cut margins of the vaginal wall are grasped to stem the bleeding. Invariably with this type of incision made at the point described the avascular areolar packed cleavage plane permits index finger separation of the areolar mesh, exposes the cul-de-sac peritoneum and displaces the rectal wall.



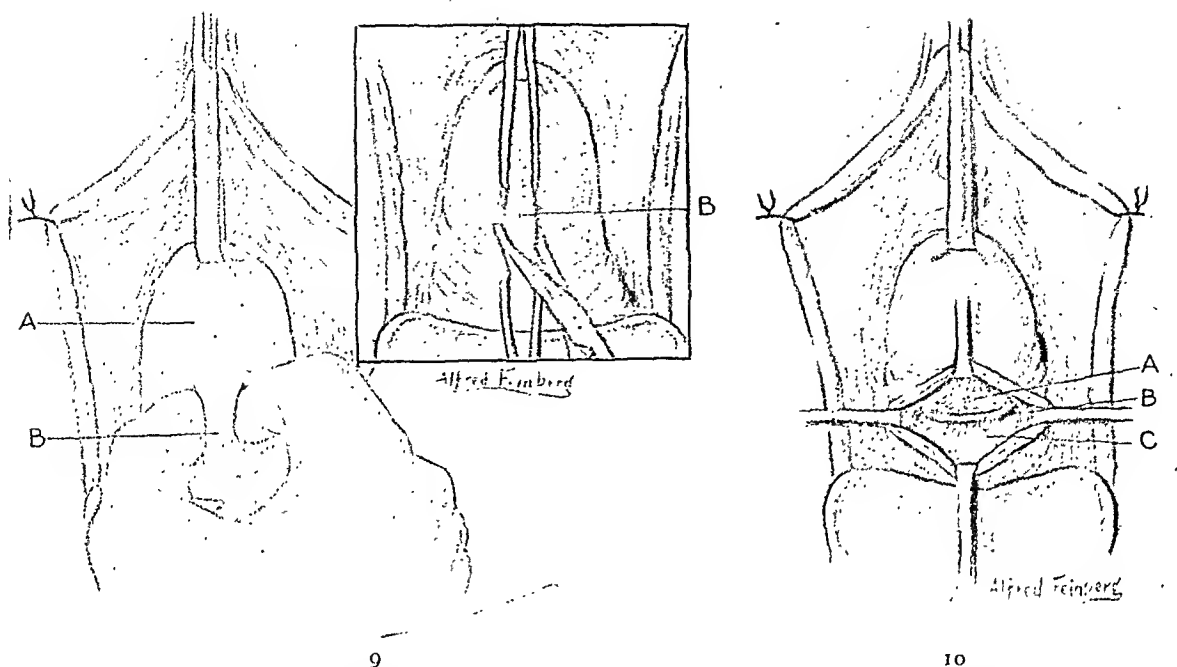


FIG. 9. Posterior surface of the cervix is exposed. A, indicates area of complete fusion of vaginal wall and cervical substance; B, indicates loose vaginal wall which is free from cervix and rectal wall. Insert: Vaginal wall marked. B, is caught between two clamps and incised. The incision should involve the entire thickness of the vaginal wall. FIG. 10. Exposed avascular areolar cleavage plane or space in the cul-de-sac area. A, posterior surface of cervix; B, beginning cul-de-sac peritoneal bulge; C, inner aspect of vaginal wall and shreds of areolar tissue.

#### CONCLUSIONS

1. The vaginal wall is completely fused with the urethral wall anteriorly and the anoperineal body posteriorly; because of these fusions, no cleavage planes or lines of demarcation exist between the vagina and these two structures. Separation of the vaginal wall from the urethral wall and the anoperineal body can be accomplished only by blunt dissection and this procedure is attended by an unavoidable ooze.

2. Between the anterior vaginal wall and the juxtaposed bladder wall there is an avascular areolar cleavage plane beginning at the urethrovesical area to the point of fusion of the vaginal wall with the cervix. A similar avascular areolar cleavage plane exists between the bladder wall and the juxtaposed cervicofundal surface ending with the vesico-uterine peritoneal fold. The existence of these cleavage planes permits a bloodless separation of the bladder from both the vagina and the cervicofundal surfaces.

3. Between the posterior vaginal wall

and the juxtaposed rectal wall there is an avascular areolar cleavage plane beginning at the anorectal junction and ending at the cul-de-sac peritoneal reflection. The existence of this cleavage plane permits a bloodless separation of the posterior vaginal wall from the juxtaposed rectal wall.

4. Neither in the normal nor relaxed state is there a surgically useful fascia lining or encasing the vagina or any of the juxtaposed organs.

5. In cystocele and prolapse of the elongated cervix the bladder wall circles away from the acute angulation made by the fusion of the anterior vaginal wall with the anterior cervical substance, accentuating an avascular space or pocket containing scattered areolar fibers.

6. In both the normal and prolapsed state between the cul-de-sac peritoneum and the juxtaposed portion of the posterior vaginal wall, as it swings pedad from its point of fusion with the posterior surface of the cervix is an avascular space or pocket filled with a loosely felted areolar mesh.

7. Technics are adequately described for the accurate approach to and exposure of the cleavage planes and avascular spaces essential in vaginal plastic surgery.

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# EFFECT OF HYDROGEN SULFIDE UPON THE BALLOONS OF INTESTINAL DECOMPRESSION TUBES

## AN EXPERIMENTAL STUDY\*

MEYER O. CANTOR, M.D., EVERETT R. PHELPS, PH. D.\* AND ROBERT H. ESLING, M.S.

*Detroit, Michigan*

IN a previous publication<sup>1</sup> we attempted to focus attention upon the fact that all balloons of intestinal decompression tubes were permeable to intestinal gases. We noted at that time that latex balloons were five times as permeable to carbon dioxide gas as were neoprene rubber balloons. Our studies at that time were carried on with carbon dioxide because of the high degree of permeability of rubber to this gas, and because carbon dioxide is present in the gastrointestinal tract of a patient with intestinal distention in a far higher percentage than in atmospheric air. Because of this disproportion between the percentage of carbon dioxide in the bowel, which ranges<sup>2,3</sup> from 4 to 18 per cent, and within the balloons of intestinal tubes which normally contain a small amount of air with a carbon dioxide percentage of 0.03 per cent, the carbon dioxide tends to diffuse from within the bowel into the balloon until there is an equalization of carbon dioxide pressures. As we pointed out, this accumulation of gas within the balloons of intestinal tubes might be a source of great danger to the patient being intubated.

Hydrogen sulfide is another gas not found in the air but often found within the gastrointestinal tract of patients with bowel obstruction. The percentage of hydrogen sulfide has been reported<sup>2</sup> as ranging from 2 to 12 per cent in some cases of intestinal distention. For this reason a study of the effect of this gas upon the balloons of intestinal decompression tubes was imperative since this gas, too, would diffuse into the balloons.

Mitchell<sup>4</sup> in 1831 in his studies on the

penetrativeness of gases noted that rubber was highly permeable to hydrogen sulfide. In his studies Mitchell found that hydrogen sulfide permeated rubber far more readily than carbon dioxide.

Because of these facts we carried out experimental studies to determine the degree of permeability of latex and neoprene rubber balloons from intestinal decompression tubes to hydrogen sulfide.

### METHODS

*Experiment No. 1.* Five balloons were used in this experiment. Hydrogen sulfide was passed into the pressure chamber containing these balloons for forty-eight hours. The pressure of the hydrogen sulfide at the beginning of the experiment was 33 mm. of mercury for the first twenty-four hours and 10 mm. of mercury for the second twenty-four hours. Glass beads in approximately the same volume were used in the balloons not containing mercury to keep the walls apart. The balloons used were: (1) Harris balloon with mercury; (2) Harris balloon with beads; (3) Miller-Abbott with mercury; (4) Cantor latex with mercury and (5) Cantor latex with beads.

*Results.* At the end of forty-eight hours no gas was found in any of the balloons.

*Comment.* This unexpected result created two questions: First, was Mitchell correct? Is rubber highly permeable to hydrogen sulfide? Is it possible that no hydrogen sulfide could diffuse into the balloons? The second possibility was: If rubber is permeable to hydrogen sulfide, can it be so highly permeable that a rubber balloon of latex cannot hold the hydrogen sulfide gas? With these possibilities in mind

\*Dr. Phelps is Professor of Physics, Wayne University, Detroit, Mich.

we proceeded to experiment further in order to decide these questions definitely.

*Experiment No. 2.* Four balloons were used in this experiment. Hydrogen sulfide was passed into the pressure chamber containing the balloons at a pressure of 100 mm. of mercury for twenty-four hours. The balloons were sealed at their mouths. The balloons used were: (1) Harris balloon with beads; (2) Cantor latex balloon with beads; (3) Cantor latex balloon with mercury and (4) Harris balloon with mercury.

*Results.* At the end of twenty-four hours the following results were obtained: (1) The Harris balloon with beads took up 60 cc. of hydrogen sulfide; (2) the Cantor latex with beads took up 8 cc. of hydrogen sulfide; (3) the Cantor latex with mercury took up no gas. The balloon was discolored black; there was a black deposit within the balloon and the walls were adherent. (4) The Harris balloon with mercury took up no gas; the balloon was discolored black and the walls were adherent.

*Comment.* This experiment is evidence for the fact that latex balloons are permeable to hydrogen sulfide. In the presence of mercury, however, a mercuric sulfide forms and the walls of the balloon become discolored and adherent with the result that no cavity remains to hold the gas.

Knowing now that latex is permeable to hydrogen sulfide, we must determine the degree of permeability in order to explain the results of Experiment No. 1. If latex is highly permeable to hydrogen sulfide, the explanation for the results in Experiment No. 1 would be obvious.

*Experiment No. 3.* One balloon was used in this experiment whose purpose was the determination of the speed of outward diffusion of hydrogen sulfide from within the balloon of a Harris tube. Therefore, a Harris tube balloon was filled with hydrogen sulfide. A pressure of 5 mm. of mercury of hydrogen sulphide was found to be sufficient to distend the balloon but not overstretch it. We avoided overstretching the balloon because that would result

in a thinning of the wall and hence would not give a true outward gas diffusion reading.

*Result.* At the end of *three minutes* a definite loss of hydrogen sulfide was noted and a definite wrinkling of the balloon appeared. At the end of *ten minutes* the pressure of the hydrogen sulfide in the balloon had dropped to 3 mm. of mercury. The balloon had lost 50 per cent of its gas. At the end of *fifteen minutes* the pressure had dropped to 2 mm. of mercury and the balloon had lost 75 per cent of its gas. At the end of *twenty-two minutes* the balloon was almost completely empty.

*Comment.* Since the permeability of rubber to a specific gas is the same under the same conditions whether the gas diffuses outward from within the balloon or diffuses from the outside into the balloon, it becomes quite apparent that latex balloons are very highly permeable to hydrogen sulfide confined within them.

*Experiment No. 4A.* Nine balloons were used in this experiment to determine the speed of diffusion of hydrogen sulfide out of various kinds of balloons. The balloons used were: (1) Harris balloon with beads. This balloon had previously been perfused with hydrogen sulfide for four days. The rubber had lost its normal shiny translucent appearance and was not as elastic as when new. The rubber was further affected by the hydrogen sulfide by becoming milky white and opaque. This balloon was filled with hydrogen sulfide until its walls were tense but not stretched. (2) Harris balloon with mercury which had been previously perfused with hydrogen sulfide for four days. This balloon was discolored black and a definite black deposit of mercuric sulfide was found within the balloon. This balloon was filled with hydrogen sulfide until it was tense but not stretched. (3) Cantor latex balloon that had been perfused with hydrogen sulfide for four days. This gas was passed into the balloon until it was tense. (4) Cantor neoprene balloon containing beads. This balloon had been perfused with hy-

drogen sulfide for four days. The balloon was now filled with hydrogen sulfide until it was tense. (5) Cantor neoprene balloon which had never been used was now filled with hydrogen sulfide until it was tense. (6) Cantor latex balloon which had never been used was now filled with hydrogen sulfide until it was tense. (7) Harris balloon which had never been used was filled with hydrogen sulfide until it was tense. (8) Balloon of Harris tube filled with air expired from the lungs until it was tense. This was a new balloon. (9) Cantor neoprene balloon was filled with air expired from the lungs.

*Results.* Balloon 1 was completely empty of gas in twenty-two minutes; balloon 2 was completely empty in twenty-two minutes; balloon 3 had lost only 50 per cent of its gas in thirty minutes. At the end of ninety minutes it had lost 75 per cent of its gas; balloon 4 had lost less than 10 per cent of its gas in sixty minutes; balloon 5 had lost less than 10 per cent of its gas in sixty minutes. At the end of two hours it had lost 50 per cent of its gas; balloon 6 had lost 10 per cent of its gas at the end of sixty minutes and 80 per cent at the end of two hours; balloon 7 had lost 75 per cent of its gas at the end of twenty-two minutes, at the end of twenty-nine minutes the balloon was empty; balloon 8 showed no change at the end of twenty-five minutes; at the end of ninety minutes there also was no change; at the end of twenty-four hours there was very slight if any change; balloon 9 showed no change at the end of twenty-five minutes, ninety minutes and twenty-four hours, respectively.

*Comment.* From this experiment it is readily evident that latex balloons are very highly permeable to hydrogen sulfide. Perfusion of rubber balloons for four days prior to the test does not appear to change the degree of permeability of the balloon to any appreciable extent. Neoprene G balloons proved to be far less permeable to hydrogen sulfide than were latex rubber balloons. Mercury-containing latex balloons react with hydrogen sulfide, chemically forming a sulphide of the mercury.

This does not appear to change the degree of permeability of the balloon, however. Balloons filled with air retain the air for some time; the outward diffusion of the nitrogen to the air is very slow.

*Experiment 4B.* Forty-eight hours after Experiment 4A the balloons were again examined and the following observations made: Balloon 3 was found to be half full of air; balloon 4 contained one-seventh of its capacity of air; balloon 5 contained one-tenth of its capacity of air; balloon 6 contained one-fifth of its capacity of air; balloon 7 was empty; balloon 8 showed very slight if any change; and balloon 9 showed slight if any change.

*Comment.* Balloons 3, 4, 5 and 6 are those which had been thoroughly flushed out with hydrogen sulfide and then filled with this gas. All this gas had diffused out in the first three hours. All the balloons used in all experiments were tightly sealed, yet air had slowly diffused into these balloons which were permitted to lie on the table.

*Experiment No. 5.* The purpose of this experiment was to determine whether a high pressure of hydrogen sulfide for twenty-four hours would result in more gas diffusing into the collapsed sealed balloons. In this experiment four balloons were used. We began with a pressure of 190 mm. of mercury. This hydrogen sulfide pressure dropped to 111 mm. of mercury at the end of the experiment twenty-four hours later. The balloons used were: (1) Harris balloon with beads which took up 18 cc. of hydrogen sulfide; (2) Harris balloon with beads which took up 14 cc. of hydrogen sulfide; (3) Cantor latex balloon which took up 9 cc. of hydrogen sulfide; (4) Cantor neoprene balloon which took up 3 cc. of hydrogen sulfide.

*Comment.* From this experiment it is evident that using very high pressures of hydrogen sulfide does not appear to increase the diffusion of the gas into the balloons. It is again evident that the neoprene rubber balloons are far less permeable than the latex.

*Experiment No. 6.* In this experiment six balloons were used. A pressure of 60 mm. of mercury was maintained in the gas chamber which contained the empty balloons. This pressure of hydrogen sulfide was maintained for twenty-four hours.

*Results.* The results were as follows: Balloon (1) Harris balloon took up 100 cc. of hydrogen sulfide; (2) Harris balloon took up 110 cc. of hydrogen sulfide; (3) Cantor latex balloon took up 20 cc. of hydrogen sulfide; (4) Cantor latex balloon took up 25 cc. of hydrogen sulfide; (5) Cantor neoprene balloon took up 8 cc. of hydrogen sulfide; (6) Cantor neoprene balloon took up 10 cc. of hydrogen sulfide. At the end of this experiment after measuring the amounts of gas within the balloons, they were replaced within the pressure chamber and hydrogen sulfide was again passed into it. Twenty minutes later when the gas chamber was opened, all the balloons were found to be empty.

*Comment.* This experiment clearly shows the very high degree of permeability of the latex balloons as compared with the neoprene. It also demonstrates how rapidly hydrogen sulfide diffuses out the balloons.

#### SUMMARY

The importance of such studies is apparent when we consider that in many cases of intestinal obstruction that the percentage of hydrogen sulfide in the bowel ranges from 2 to 12 per cent and that no hydrogen sulfide is found in atmospheric air. The effect of the law of diffusion of gases is such that gases tend to diffuse from areas of high concentration to those of low concentration until equal pressures are obtained. That being the case, if a balloon of a long intestinal tube is present in a distended bowel containing any appreciable amount of hydrogen sulfide, we would expect the hydrogen sulfide to diffuse into the balloon since the balloon wall is a permeable membrane to this gas. As a result of our *in vitro* studies we can state definitely that latex balloons are very highly permeable to hydrogen sulfide gas.

This gas changes the physical character of the latex rubber with which it comes into contact. In the presence of mercury within the balloon a black deposit of mercuric sulfide is formed with the balloon. This chemical reaction, however, does not appear to alter the permeability of the latex balloon. Neoprene rubber balloons are far less permeable than are the latex balloons.

Because the balloons of intestinal tubes are so highly permeable to hydrogen sulfide, this specific gas does not constitute a hazard in intubation even when found in appreciable amounts in the gastrointestinal tract. The reason for this is that with intestinal decompression and the removal of the intestinal gas (hydrogen sulfide) the hydrogen sulfide within the balloon diffuses outward in a matter of minutes.

#### CONCLUSIONS

1. Latex intestinal tube balloons are far more permeable to hydrogen sulfide than are neoprene rubber balloons.
2. Latex balloons are very highly permeable to hydrogen sulfide.
3. Hydrogen sulfide changes the character of the balloons. There is a loss of elasticity and a marked discoloration. If mercury is present in the balloons, mercuric sulfide is formed. This does not change the degree of permeability of the balloon.
4. Perfusion of the balloons with hydrogen sulfide does not appear to change the permeability of the balloons.
5. Because of its high degree of permeability and the speed of its outward diffusion, hydrogen sulfide does not constitute a hazard in intubation.

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# THE TRAUMATIC CONDITION OF THE ABDOMEN\*

ARTHUR R. METZ, M.D., RAYMOND HOUSEHOLDER, M.D. AND  
GERRIT DANGREMOND, M.D.

Chicago, Illinois

**I**NJURIES to the intra-abdominal organs are not uncommon and usually are serious. Their successful management depends on early, accurate diagnosis followed by immediate intelligent treatment. An understanding of the anatomy

organs are the liver, spleen, kidneys, suprarenals and pancreas. These organs are supported by the mesenteries and accompanying blood vessels. (Fig. 1.) It is noteworthy that the mesenteric attachments are rather weak and elastic and the blood vessels are subject to injury resulting in fatal hemorrhage.

A transverse section of the abdomen at the level of the first lumbar vertebra shows that this more-or-less centrally located abdominal area contains a part of practically all the abdominal viscera except the lower intestine and urinary bladder. (Fig. 2.) Trauma to the abdomen at this level could easily injure any one of these important organs.

The various openings, such as the internal inguinal rings and the openings through the diaphragm, are possible points of trouble due to herniations of the abdominal contents. However, in the author's experience no hernias have occurred as the result of a single injury.

The solid organs have a more-or-less constant size and shape and undergo but little variation with changes in the physiologic status of the individual. The spleen becomes engorged and full after the ingestion of a meal. The other solid organs vary but little in size.

The hollow organs vary considerably in their size and shape during the normal daily activities. After a meal the stomach will increase greatly in size as will the small bowel when food enters the lumen. The urinary bladder will vary in size. Distended organs are more liable to injury than when empty; consequently, abdominal injuries are more likely to produce damage

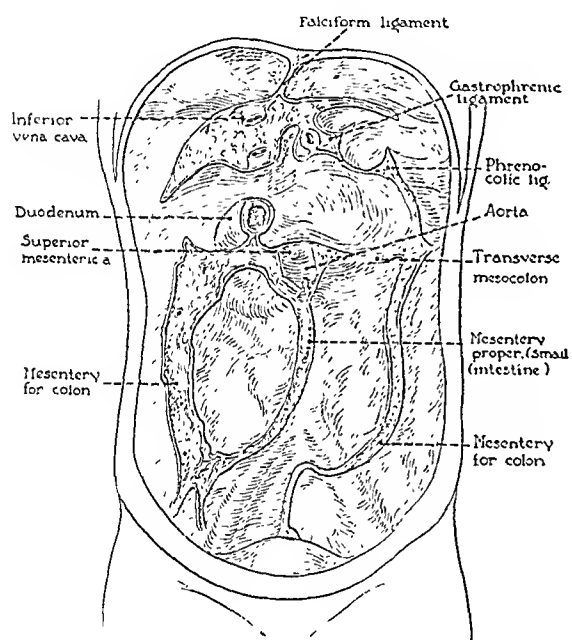


FIG. 1. Mesenteric attachments.

of the abdominal area, the mechanism of injury and a thorough routine of examination are essential in caring for the patient who has sustained trauma to the abdomen.

**Anatomy.** The abdominal area consists of the abdominal walls supported by the ribs and spine, anchored to the bony framework at the lower portion which is the pelvis. Within the abdominal area are the hollow organs, such as the stomach, small and large intestines, gallbladder, bile ducts, urinary bladder and urethra. The solid

\* Read before the Section on General Practice of Medicine at the One-Hundredth Annual Session of the American Medical Association, Atlantic City, June 12, 1947.

to the hollow viscera when sustained soon after the ingestion of food.

*Mechanism of Injury.* The most common causes of abdominal trauma are as follows: (1) Direct violence, such as a blow to the abdomen by some blunt object

whether he had to sit down or stop work for a short period of time or whether loss of consciousness occurred immediately. Did the patient vomit and, if so, was blood present in the vomitus? Does the patient remember the details of the accident? This

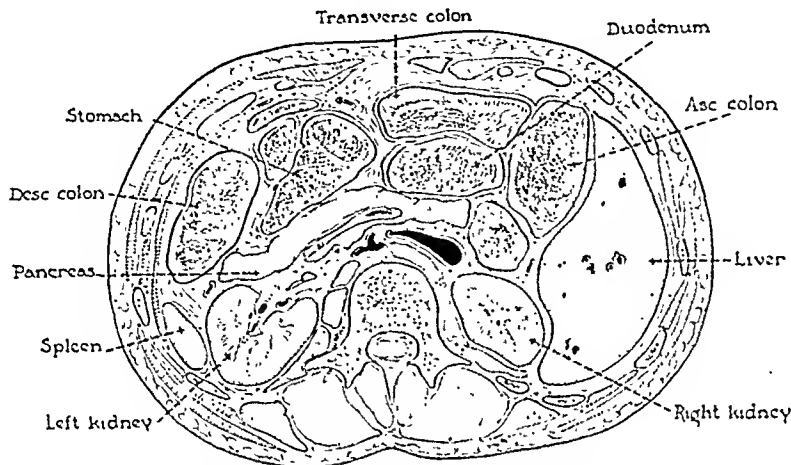


FIG. 2. Transverse section, level first lumbar vertebra.

as a piece of wood or a tool that the individual may be handling. (2) Indirect violence as a fall from a height of a few feet or more, the impact of landing producing the injury. (3) Non-penetrating wounds, for example, squeezing injuries from being caught between moving objects. (4) Penetrating wounds such as from a stab or gunshot.

#### EXAMINATION OF THE PATIENT

Success in managing cases of traumatic injuries to the abdomen may well depend on the primary examination of the patient and the recorded findings by the first attending physician. A thorough examination routine is helpful and should be combined with taking of an accurate history concerning the injury.

An accurate history and description of the mechanism of the accident should be obtained to determine amount of violence, distance of the fall or any other factors that may be of value in determining the possible severity of the injury. (Fig. 3.) The patient's reaction immediately following the accident should be ascertained—whether he noticed a sudden, sharp pain,

information may have important bearing in helping to determine the extent of injury and in arriving at a diagnosis. In addition

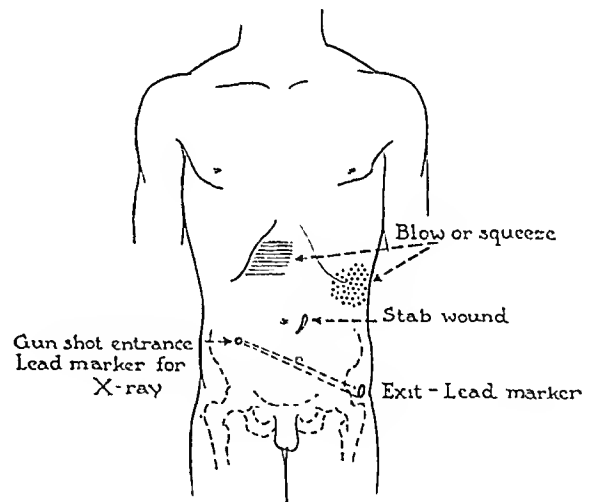


FIG. 3. Mechanism of injury.

it may be valuable for future reference as stories of accidents frequently change after time has elapsed.

When the patient is first seen, particular attention should be given and a record made of the degree of shock, volume and rate of the pulse, blood pressure, temperature and respirations. (Fig. 4.) The blood



count and urinalysis should be made. This gives the physician a base line concerning the status of the blood so that changes may be noted on frequent repeated counts. The presence or absence of blood in the urine is to be noted. It may be necessary to catheterize the patient to obtain a specimen.

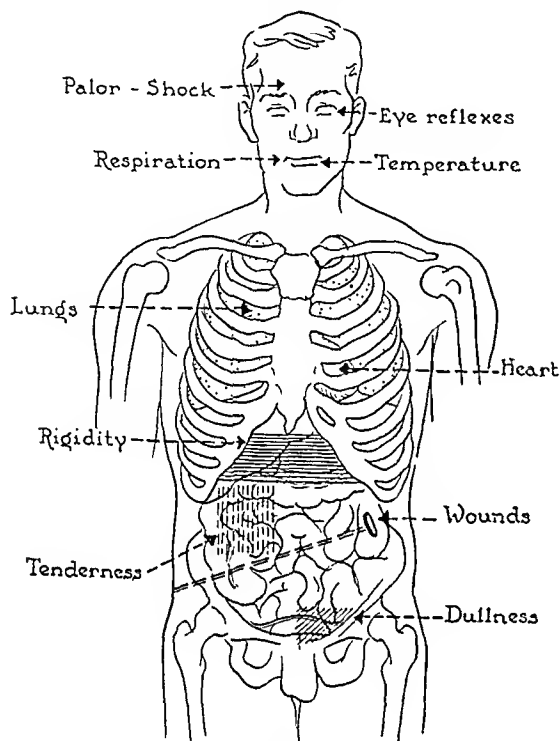


FIG. 4. Examination of patient: blood count, urine, blood pressure, record findings frequently; at least every thirty minutes mark areas of pain and dullness on the skin.

On physical examination careful inspection should be made to notice any external evidence of injury such as swelling, abrasions, areas of redness or open wounds. Clinical evidence of fractures about the pelvis, spine or ribs should be noted. Palpation of the abdomen will determine if there are any local points of tenderness or muscular resistance. Areas of dullness or tympany will be discovered by percussion. It is well to mark off such regions with ink. Thus any shifting of these areas may be determined and easily checked at repeated examinations. Bleeding from the orifices of the body such as the urethra and rectum give clues to likely sites of injury. This indicates careful digital examination of the

rectum and, in the case of a female, bimanual pelvic examination.

Radiograms showing the entire abdomen, including the pelvis and lower chest, should be taken. This survey will rule out or determine fractures of the pelvis, ribs and lower vertebrae. The anteroposterior and lateral views are used, the latter being helpful in determining the presence of free air in the abdominal cavity. Opaque foreign bodies are discovered by x-ray. To facilitate x-ray interpretation lead markers placed on the skin of the patient can be used to indicate wounds, points of entrance and exit of missiles and localized areas of pain as pointed out by the patient.

If after a careful history, physical and special examinations the extent of injury is not evident, the patient should be put to bed for observation. Repeated examinations should be made at least every thirty to sixty minutes until a positive diagnosis is reached. It is advisable to avoid, if possible, sedative drugs such as morphine during the period of observation as they tend to mask important symptoms.

The surgeon should attempt to make a positive diagnosis of intra-abdominal injury within six hours from the time of accident, preferably within two to four hours. A patient operated upon within six hours, as a rule, has a good chance for recovery; after six hours his chance of recovery greatly diminishes.

#### MANAGEMENT AND TREATMENT

When shock is present, it should be treated promptly by elevating the foot of the bed, with general supportive measures of intravenous fluids, plasma or blood as indicated. Oxygen by nasal tube is efficacious. Use of hot water bottles, electric pads or other sources of heat should not be used as they dilate surface capillaries, tend to produce loss of body fluids, lower blood pressure and increase oxygen needs of the body.

In perforating wounds of the abdomen, such as gunshot or stab wounds, it is apparent that the abdominal wall has been

pierced so that immediate operation to repair the defects should be performed. This type of injury is usually evident and need cause no delay in diagnosis and deciding the treatment.

In selecting an anesthetic preference is given to nitrous oxide, cyclopropane or ethylene, preceded by one or two injections of morphinescopolamine depending on the available time before the operation is begun. We have found the use of intravenous curare (intocostin) materially aids in providing desirable relaxation of the abdominal musculature when given before and during inhalation anesthesia.

Use of penicillin and sulfa drugs is a valuable adjunct to the surgical management of intra-abdominal injuries. The peritoneum itself has remarkable powers of combating infection. This power is enhanced by removal of sources of infection and by closure of all perforations in the hollow viscera. Infection *per se* is a less frequent cause of death than shock or hemorrhage.

Intact skin is no guarantee that an intra-abdominal injury is not present, and both hollow and solid organs may be injured by local or diffuse non-penetrating force. The decision to explore an abdomen following non-penetrating trauma is a more difficult one than the clear cut obligation in penetrating wounds. This decision will depend on the general appearance of the patient, pulse, blood pressure, abdominal signs and laboratory findings. The history of trauma followed by early localized abdominal pain becoming generalized suggests leakage. A ruptured hollow viscus causes immediate peritoneal irritation, with a resultant pale, drawn face and apprehensive expression. Additional signs are pain aggravated by motion, vomiting, rapid costal breathing, abdominal tenderness, rigidity and tympanities. Immediate exploratory laparotomy is indicated with severe persistent pain, i.e., continuous or intermittent, localized or general associated with vomiting or retching, diffuse tenderness and muscle spasm with or without signs of hemorrhage.

The choice of incision depends on the tentative diagnosis as to which organ is suspected of injury. The upper abdomen may be approached either through the high midline, right or left rectus or transverse incisions. The lower abdomen may well be reached through a midline, right or left rectus or paramedian incision. There are many advocates of the transverse incision. The abilities and habits of the surgeon will influence the type of incision used. Injuries to the solid organs will usually result in hemorrhage and on opening the peritoneum free blood will be found. A systematic exploration is carried out starting at a fixed point. The viscera are examined for lacerations and bleeding points and the mesentery is inspected. Care in handling the tissues is important. The injury is located and treated as indicated.

Closure of the abdomen following exploration and repair of the damaged tissues is preceded by a final toilet of the peritoneal cavity by aspiration and sponging. Use of the sulfonamide compounds in the peritoneal cavity is a valuable adjunct to surgical treatment. The closure is carried out by use of interrupted figure of eight chromic catgut sutures. Drainage depends on the situation and judgment of the surgeon. Drainage of wounds is indicated in the presence of bile in the abdomen and pancreatic wounds.

*Liver.* The liver by its large size, fixation, friability and slight elasticity is predisposed to lacerations. (Fig. 5.) Injuries to the gallbladder and cystic and common ducts may accompany liver trauma.

The clinical picture will depend on the extent of parenchymal and vascular damage. It will vary from slight distress in the right hypochondrium to profound shock. Peritoneal irritation due to bile and blood may refer pain to the right scapular region. X-ray study may reveal elevation and immobilization of the right half of the diaphragm.

Penetrating wounds may be clean cut lacerations, fragmented wounds with single penetrations which can tear an entire

lobe. Non-penetrating trauma, such as squeezing or falling injuries, can result in rupture of the capsule and liver parenchyma and central rupture. Injuries to the liver may be treated conservatively if one can be reasonably sure that the patient is not

main clinical feature associated with pain, tenderness, rigidity and left shoulder pain.

X-ray study may reveal immobile or elevated left diaphragm. There is an increase in the area of splenic dullness and gastric tympany may be obliterated. Splenic

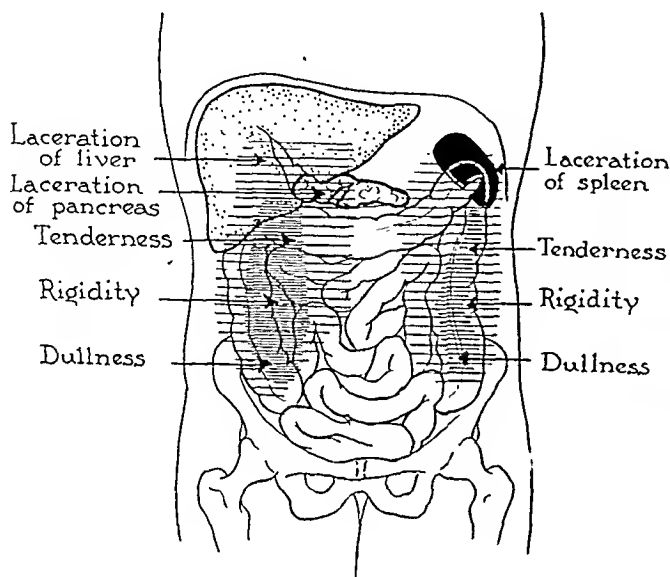


FIG. 5. Injury to liver, pancreas and spleen.

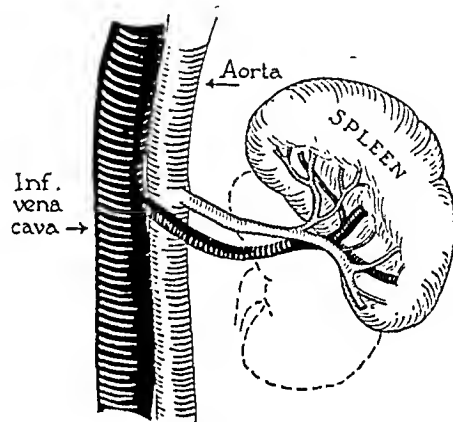


FIG. 6. Blood supply of the spleen.

developing a serious hemorrhage. With evidence of internal hemorrhage, it is essential to open the abdomen and control the source of bleeding. Injuries to the liver can best be managed by resorting to suturing, simple gauze pack or omental or muscle grafts. The use of a gelatin sponge with thrombin is proving a very valuable aid in this type of wound.

**Gallbladder and Common Duct.** Gallbladder tears may require cholecystostomy or removal of this organ. Injuries to the common bile duct, although rare, may be found and require repair over a T-tube or anastomosis to the gallbladder, duodenum or stomach.

**Spleen.** The spleen is injured by penetrating wounds or by blunt trauma including fractured ribs. (Fig. 6.) The spleen is mobile, lacks elastic tissue and is protected to some extent by the left thoracic cage. Lesions vary from small fissure-like tears to extensive lacerations with separation at the pedicle. Hemorrhage is the

injuries show two clinical pictures: one of immediate hemorrhage and subsequent signs of shock from hemorrhage and second, that of delayed hemorrhage with a latent period of a few hours to several weeks. Repair of the spleen is almost never attempted. The spleen can be removed without subsequent ill effects. Care must be taken not to injure the pancreas or the stomach during removal of the spleen.

**Pancreas.** The pancreas is situated in the lesser peritoneal sac, rests on the vertebral column and is well protected. Injuries caused by direct penetration, blows to the epigastric region or by crushing the pancreas against the vertebral column are seen. There may be lacerations of the head, body or tail or simple contusion to the pancreas. Clinically, shock is usually severe with excruciating pain in the epigastrium. A mass may form above the umbilicus. Use of the blood serum amylase test is helpful when doubt exists concerning pancreatic injuries. An elevation of the

serum amylase value is indicative of injury to the pancreas.

The pancreas is exposed through the opening of the lesser or gastrocolic omentum. Lacerations of the pancreas are repaired with non-absorbable sutures. Any devitalized tissue is removed and divided ducts, if not reparable, are ligated. Soft rubber tissue drains are placed down to the injured pancreas. Cysts which may form from hemorrhage into the substance or into the lesser peritoneal cavity are incised, emptied and marsupialized.

**Kidney.** Injuries to the kidneys are fairly common complications of abdominal trauma. (Fig. 7.) The hilum and large vessels if injured may result in necrosis of the kidney with resultant infection as the renal arteries are terminal. If the kidney pelvis is damaged, leakage of urine into the retroperitoneal tissues or peritoneal cavity results. Parenchymal perforations, lacerations or bisection of the kidney, injury to perirenal tissue with hemorrhage and subsequent infection are problems seen in kidney injuries.

Hematuria, the most prominent symptoms in renal injuries, is usually present from the onset and may persist for one to two weeks. Associated with hematuria is pain in the back which may increase in severity so as to require sedatives. A moderate degree of shock is present and may result in anuria. Reflex peritoneal irritation may be manifested by adynamic ileus and abdominal rigidity.

X-ray studies may demonstrate a foreign body and evidence of renal injury, such as change in size and contour of the kidney and absence of the psoas muscle outline. Intravenous urography may be helpful. Retrograde pyelographic study may be dangerous and make immediate surgery imperative. The firm capsule of the kidney will control hemorrhage except in extensive tears.

If the patient's general condition progresses, satisfactorily, conservative and supportive management is indicated although the use of drainage in the loin may be

necessary later. If the patient's condition appears critical, it may be necessary to explore the kidney area to control hemorrhage and institute drainage. In some cases prompt nephrectomy is indicated.

**Stomach.** The stomach by its large size and relatively exposed anatomic posi-

Rupture of spleen

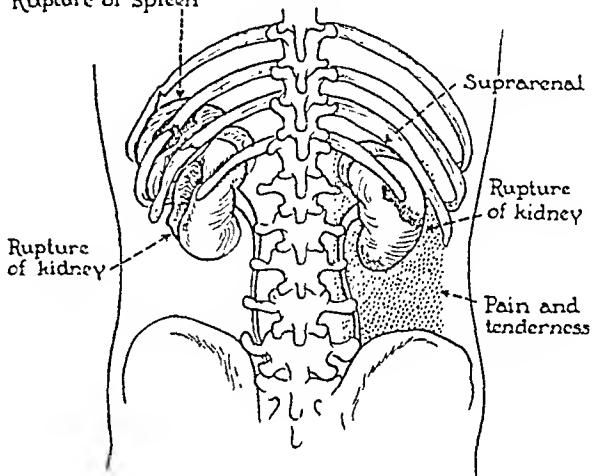


FIG. 7. Injury to kidneys, suprarenals and spleen.

tion in the abdomen is subject to injury either from penetrating wounds or from blunt trauma to the upper abdominal wall. (Fig. 8.) The injuries may vary from simple perforations to jagged tears and may include one or both walls. The rich blood supply to the stomach allows for possible severe hemorrhage.

Clinically, the patient may complain of severe epigastric pain of a localized or diffuse type. Muscular rigidity is usually "board-like" but may vary to a lesser degree. X-ray studies may reveal free gas in the peritoneal cavity usually located just below the diaphragm.

Management calls for immediate operative intervention with exposure of the stomach usually through a midline or left rectus incision. Adequate exposure of the stomach and thorough examination, including the posterior wall, is necessary. Enlargement of anterior perforations to expose the posterior wall is permissible when indicated. Perforations and tears are closed in layers after débridement, using layers of chromic catgut, the last row being the Lembert type of suture. Only rarely is

gastro-enterostomy or gastric resection indicated. Decompression by means of the Levine tube and Wangenstein suction is used for the first twenty-four to seventy-two hours postoperatively. Intravenous fluids may be employed to maintain proper nutrition and fluid balance of the patient.

Exteriorization of the injured segment and enterostomy may be necessary in isolated cases. In duodenal injuries exploration of the anterior and posterior surfaces is required. The posterior surface will call for mobilization by means of lateral incisions along the anterior border

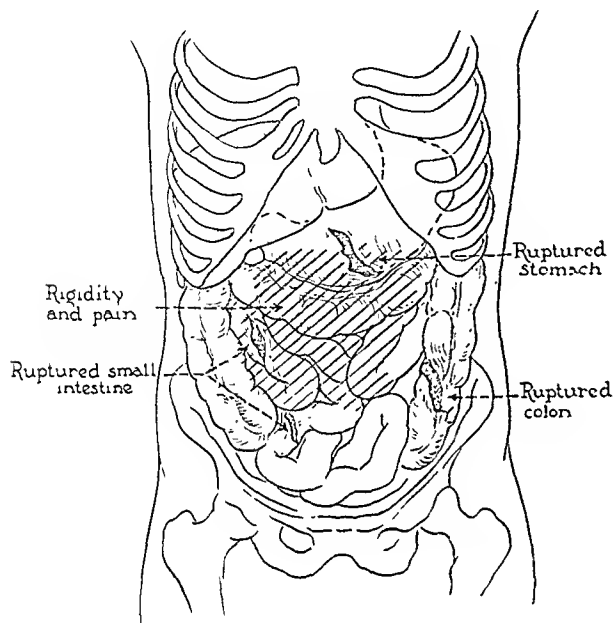


FIG. 8. Injury to stomach and intestines.

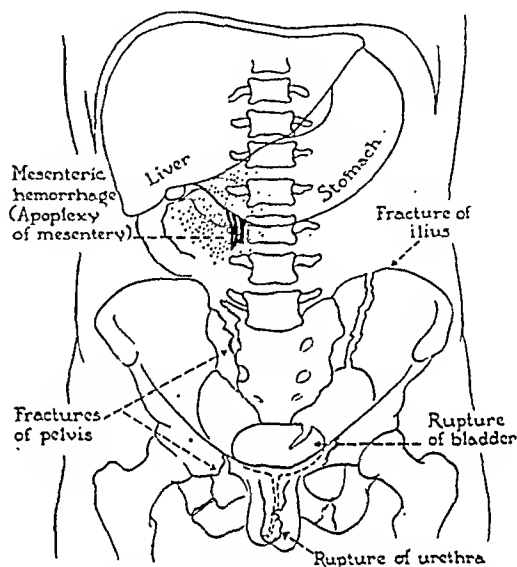


FIG. 9. Injury to bladder, urethra, pelvis and blood vessels.

*Small Intestine.* The close proximity of the intestinal coils and the anatomic features makes the small intestine vulnerable to multiple perforations and tears. The duodenum being in a fixed position may be crushed against the vertebral column. The ileocecal and duodenojejunal junction are possible sites of rupture. The clinical signs are those of peritoneal irritation. These signs may be delayed until bowel activity is later stimulated. X-ray may reveal free gas in the peritoneal cavity and in case of duodenal injuries may reveal gas about the retroperitoneal tissues.

Simple perforations are closed in the transverse axis using self-inverting Connell suture supplemented by a Lembert suture. Larger tears may require lateral or end-to-end anastomosis or resection when large segments of bowel are destroyed.

of the duodenum and mesial retraction to expose its fixed retroperitoneal surface. Single perforations are closed. If the duodenal lumen is narrowed, a gastro-enterostomy is indicated. Larger or complete tears may require partial gastrectomy with closure of the duodenum.

*Large Intestine and Rectum.* Any section of the large intestine and rectum may be injured by perforating wounds. The cecum, hepatic and splenic flexures may be ruptured by non-penetrating trauma. Wounds may vary from isolated contused areas to large perforations and ragged tears. Due to the anatomic features of the large intestine, extreme care must be used in management of the large bowel injuries. The blood supply of the large bowel is specifically from three major sources: the superior mesenteric, the inferior mesenteric

and the internal iliac branches. The adequacy of blood supply to the remaining bowel is important in resecting injured segments. A large portion of the colon is retroperitoneal. Colon injuries in the retroperitoneal location may be easily overlooked and lead to severe infection of the connective tissue planes and muscles of the posterolateral abdominal wall. If proper primary care is not given to this type of injury, these infections may lead to a fatal outcome.

The rectum may be injured in associated wounds of the buttock, pelvis, flank and thigh. Compressed air injuries to the rectum are on record.

Treatment of large bowel injuries varies from the simple suture with omental graft to resection or exteriorization and colostomy proximal to the site of injury. Mobilization of the colon for retroperitoneal perforations may be necessary. Rectal injuries with suspicion of peritoneal involvement indicates immediate laparotomy.

Management of rectal wounds requires débridement of the original external wound, repair of the rectal defect, with drainage of retrorectal space and colostomy if indicated. Colostomy is to be considered in management of all rectal wounds.

*Mesentery and Blood Vessels.* A tear in the mesenteries of the bowel would give the picture of hemorrhage and indicate exploration and repair of the defect. Resections of the triangular area with accompanying devitalized bowel may be necessary. Retroperitoneal hemorrhage is treated conservatively and only when the clinical picture indicates increasing hemorrhage is operative intervention carried out. Infection of hematomas requires drainage.

Trauma to the large vessels of the abdomen such as the aorta or vena cava may cause profuse hemorrhage and require rapid treatment. The use of suture, and recently the gelatin sponge, will close these defects if operative treatment can be carried out before the patient becomes exsanguinated.

Pelvic fractures are included here because of the frequency with which the intra-abdominal organs may be injured by pelvic bone fragments. The rectum, urinary bladder and urethra are the organs most commonly involved. In pelvic fractures the attending physician must be alert to the possibility of an accompanying injury to vital soft parts.

*Urinary Bladder and Urethra.* The urinary bladder may be injured by penetrating wounds, nonpenetrating trauma to lower abdomen or by associated pelvic fracture. (Fig. 9.) The wounds may vary from a small puncture type to an extensive laceration. Wounds of the dome and posterior wall of the bladder are intraperitoneal, those involving the anterior, lateral walls and base of the bladder are extraperitoneal. The intraperitoneal type may also involve the small intestine and pelvic colon. Extraperitoneal wounds are followed by urinary infiltration, destructive cellulitis and widespread necrosis unless proper drainage is promptly carried out. Local pain results from urinary extravasation. Blood may be present in the urine. A full bladder suggests absence of leakage while an empty bladder indicates an intraperitoneal extravasation.

Treatment of the urinary bladder wounds is carried out by débridement, repair of the laceration and proper drainage of tissue spaces of the pelvis. Suprapubic cystotomy is indicated.

The urethra is injured by similar mechanisms as the urinary bladder or by falling astride a firm object. Lacerations of the posterior urethra may necessitate repair to restore continuity to its lumen for when it is completely severed, the ends tend to retract which makes it impossible to pass a catheter or urethral sound. (Fig. 10.)

The perineal approach to repair the urethra has been commonly employed which requires considerable dissection and is frequently very difficult. A simpler method, which was first described by Dr. George G. Davis of Chicago and later popularized by Dr. Vincent J. O'Connor of

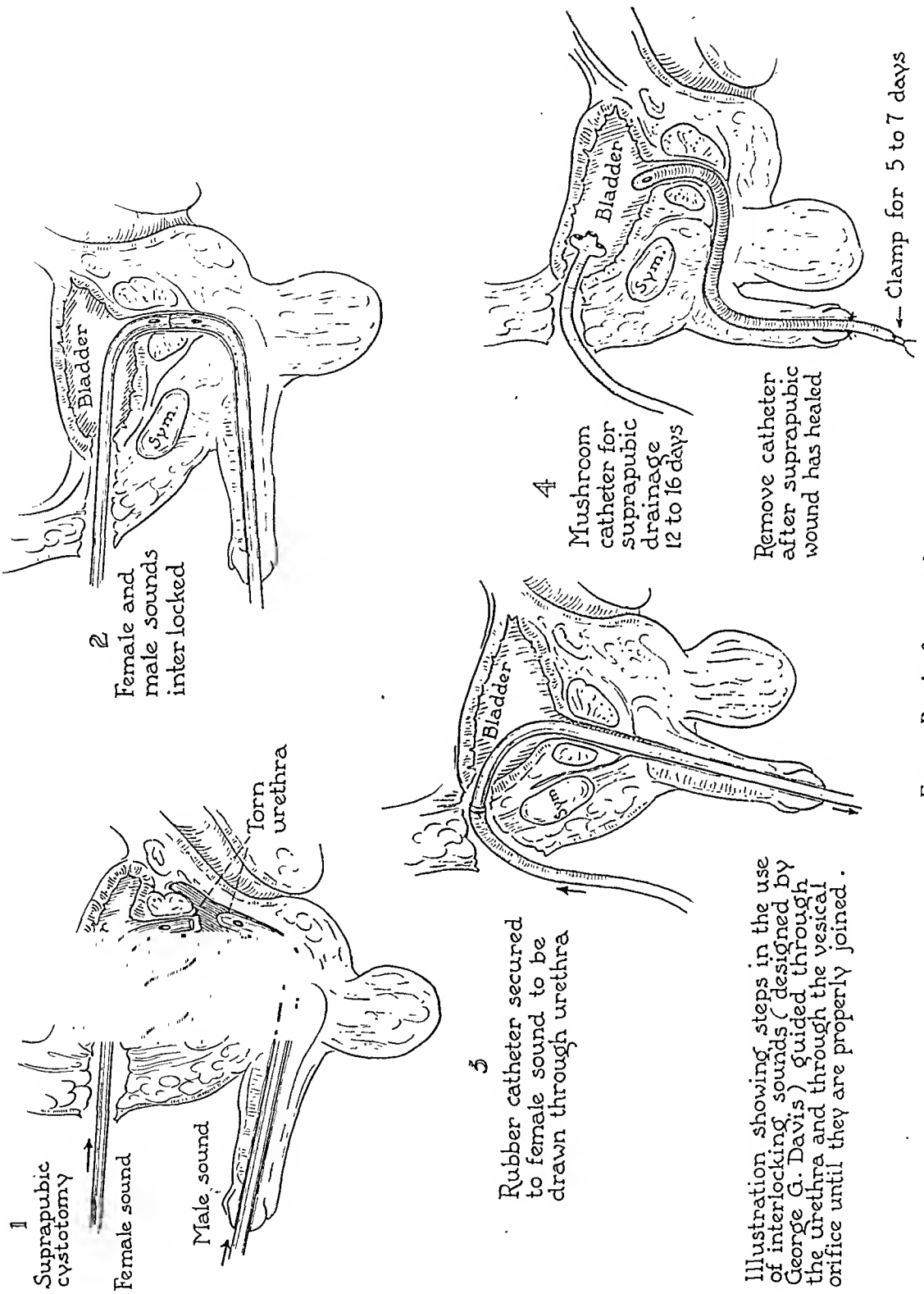


Illustration showing steps in the use of interlocking sounds (designed by George G. Davis) guided through the urethra and through the vesical orifice until they are properly joined.

FIG. 10. Repair of torn urethra.

Chicago, consists in doing an extraperitoneal suprapubic cystotomy with retrograde splinting of the urethra by indwelling catheter. Perineal incision is used only when necessary to drain extravasated blood and urine.

As shown from the schematic drawings, interlocking sounds are passed simultaneously through the posterior urethra and anterior urethra and joined in such a way that the urethra introduced member (male sound) may be fitted snugly into the second passed through the bladder neck (female sound) thus permitting the former to be guided safely into the bladder. A No. 22 soft rubber catheter is then stitched securely over the end of the male sound and the edges of the catheter are tied tightly to approximate the taper of the sound thus facilitating the ease of drawing the catheter back through the urethra and assuring a smooth passage through the friable ruptured portion.

When the catheter has been placed in the urethra in its proper position, it is sutured to the meatus on the underside so that it remains in position for about twelve to sixteen days. The bladder is closed in the usual manner with a mushroom catheter in the dome for immediate drainage. The urethral catheter is closed for five to seven days and then opened. The bladder is irrigated and the suprapubic catheter is removed in about twelve to sixteen days.

The urethral catheter is removed when the suprapubic wound seems firmly healed, usually by the sixteenth day after operation. This method as a rule gives complete restoration of normal urinary function with subsequent lack of urethral stricture as compared with the results obtained in a patient operated upon by the perineal route. The patients may later require an occasional urethral dilatation.

#### CONCLUSIONS

It is important in any history of injury or violence about the abdominal area that the patient be given a thorough and careful examination at once to determine the extent of injury. Special attention should be directed toward obtaining an accurate account of the mechanism of injury, a careful physical examination, recording of findings and prompt laboratory and x-ray examinations. Frequent observations should be made to observe the progress of symptoms and physical findings so as to give prompt surgical treatment when indicated.

Patients operated upon within the first six hours after a severe injury have better chances of recovery than those patients in whom surgery is delayed beyond the six-hour period. In case of doubt it is safer to explore the abdomen than to delay surgery too long as it may jeopardize the life of the patient.





# EXPERIENCE WITH THE NORTON EXTRAPERITONEAL SECTIONS\*

LORMAN L. LEVINSON, M.D. AND LOUIS H. DOUGLASS, M.D.

*Baltimore, Maryland*

EXPERIENCE at the University of Maryland with any type of extraperitoneal section prior to 1947 was very scant. One Latzko section had been done in 1926 and one was done ten years later. In 1942 two of the Waters type of extraperitoneal section were done, two in 1943 and, again, one in 1946. In 1947 the junior author assisted in two more of the Waters type of extraperitoneal operation and was impressed with one thing, namely, that the operation was technically difficult, at least to the occasional operator. He believed and still believes that there is a definite place in the armamentarium of the obstetrician for the extraperitoneal section and in an effort to discover the relative merits of the two leading types, the Waters and the Norton, a visit was made to the Margaret Hague Maternity Hospital in February, 1947. There it appeared to the observer and was gathered from general conversation that the Norton was the easier operation. It required less sharp dissection and offered fewer blind fascial tunnels which eventually led either into the bladder or into the peritoneum; this happened all too often in our brief experience with the Waters section.

Since it was desired to gain as much experience with the Norton section as possible and since it was believed that no harm would result to the patient in the elective cases even if the peritoneal cavity was entered, the operation was extended to include those cases which did not actually meet the general requirements for an extraperitoneal section. Twenty-three cases were thus accumulated in a little less than a year for the period ending March 1, 1948.

Norton says cases may be divided into those: "(1) potentially infected and (2) frankly infected. . . . The potentially infected . . . any patient in labor for a period of eight (8) hours or more with ruptured membranes for a similar duration of time, is potentially infected in the sense that pathogenic micro-organisms have gained access to the amniotic sac; the longer and further this type of labor progresses, the more likely the patient is to be frankly infected."<sup>1</sup>

The University of Maryland Obstetrical Clinic has followed further along in this interpretation of infection in labor. The patient is potentially infected if she has been in labor for eight hours or more with or without ruptured membranes. The important consideration is that the patient is infected. Whether this infection is potential or frank is not too important except in severely infected patients. Norton warned about this type of case when he reported two maternal deaths due to overwhelming infection in a series of 163 cases of paravesical extraperitoneal section. One case was associated with severance of the left ureter and injury to the bladder and the other was associated with peritonitis following entry into the peritoneal cavity after sixty hours, with ruptured membranes and fifty-five hours of hard labor. These deaths occurred in 1935 and 1936, prior to the days of chemotherapy and antibiotics, and represented two of three maternal deaths in this whole series; the third death was due to postoperative hemorrhage from an atonic uterus. Our experience in this particular series with the very badly infected patient is nil. We

\* From the University of Maryland Hospital, Baltimore, Md. Read before The Travel Club, Virginia Obstetrical and Gynecological Society, April 21, 1948.

believe that cesarean hysterectomy, as advocated by Dieckmann and others, might be indicated in those very severely infected, although extraperitoneal section properly performed plus chemotherapy and antibiotics should handle the majority of these cases.

Twenty-three cases of the Norton type of paravesical extraperitoneal section are presented and indications for section are tabulated. (Table 1.) They are further subdivided into those cases which meet the requirements just mentioned for extraperitoneal section and those cases in which the extraperitoneal approach was optional.

TABLE I

Indication for Section	No. of Cases	Extra-peritoneal	
		Indicated	Not Indicated
Disproportion, cephalopelvic....	11	7	4
Dystocia, positional, occiput posterior with borderline disproportion, cephalopelvic.....	3	3	0
Presentation of funis.....	1	0	1
Section previous for disproportion, cephalopelvic.....	3	1	2
Stricture, rectal.....	1	1	0
Pre-eclampsia, severe.....	2	0	2
Tuberculosis, bilateral, hip, chronic.....	1	0	1
Presentation mentum transverse in elderly primigravida.....	1	0	1
Total.....	23	12	11
Percentage.....	100	52.17	47.83

One case (E. J.) was particularly controversial. The patient, a twenty-three year old unregistered colored primigravida, was admitted to the hospital at 12:30 A.M. on August 19, 1947, after approximately forty-nine hours and thirty minutes of labor at home under the supervision of first a midwife and then a local physician. Upon admission rectal findings were inconclusive except that the patient had a very large baby estimated to be about 4,500 Gm. A sterile pelvic examination revealed the cervix to be thick, boggy and

4 to 5 cm, dilated, the presenting part in the left occiput posterior position, the head unengaged, 2 plus caput formation and considerable overlapping of the cranial bones. The fetal heart was not definitely heard although at the time of admission one observer thought it could be heard in the left lower quadrant. The membranes were ruptured at the time of the sterile pelvic examination. The patient was on penicillin therapy and was kept well hydrated with intravenous fluids. A cephalopelvimetry was interpreted as a small gynecoid pelvis with marked cephalopelvic disproportion, the baby in the left occiput posterior position with mild extension of the head. There was marked molding and overlapping of the cranial bones. The fetal heart could not be heard later in the day even by the observer who had first believed it was present. The patient's general condition remained good. Temperature twelve hours after admission was 100°F., pulse 130 and respirations 22. The patient continued in labor. About 4 P.M. the cervix was 7 to 8 cm. dilated, the presenting part was still unengaged and the baby was probably dead. The mode of delivery was then the problem. Should the patient be delivered from below by craniotomy? Would the prolonged labor of over sixty-five hours by this time so have thinned out the lower uterine segment that intra-uterine manipulation might possibly rupture the uterus and thus spill the frankly infected contents into the peritoneal cavity? Would it not be better in this case, even with the realization that the baby was probably dead, to perform an extraperitoneal section? The consultant and the resident believed that the latter was the procedure of choice although there was some disagreement from other sources, and the patient was delivered of a full term, dead, male child weighing 5,415 Gm. from the left occiput posterior position at 8:21 P.M., March 19, 1947, by Norton extraperitoneal section. The third stage of labor was normal; total labor was sixty-nine hours and twenty-one minutes. The fetus was found to be slightly macerated, the lower

uterine segment was paper thin and it was necessary to perform a craniotomy and a bilateral cleidotomy in order to deliver the baby. There was no extension of the uterine incision and the peritoneal cavity was not opened. There was no injury to the bladder. The large size of the baby was suspicious of maternal diabetes mellitus and subsequent work-up confirmed this diagnosis. The patient's postoperative course was afebrile on penicillin and sulfadiazine therapy. Sutures were removed on the eighth day and the wound was well healed with no evidence of infection. She was allowed up on her tenth day and was discharged in good condition on her fifteenth postoperative day.

#### TECHNIC

The general technic for this operation follows that outlined by Norton, except for several minor points: Anesthesia is usually spinal, most of these operations being done with 20 mg. of pontocaine with 2 cc. of 10 per cent dextrose. A Foley catheter is inserted into the bladder and connected to a bladder irrigation bottle containing a colored solution, usually indigo carmine or methylene blue. Abdominal preparation is carried out and patient is draped per routine. A left paramedian incision is made from a point approximately 6 cm. below the umbilicus down to the symphysis pubis. The anterior rectus sheath is exposed and incised. The left rectus muscle is then separated by blunt dissection from the underlying transversalis fascia while the bladder is distended with approximately 200 cc. of colored solution. The left rectus muscle is then lifted upward and retracted laterally. An area of yellow "chicken fat" is then identified at the left superior lateral surface of the bladder (the left paravesical space). The index finger of each hand is inserted into the region of the yellow "chicken fat" and by blunt dissection the transversalis fascia and the anterior sheath of paravesical fascia is lifted from the bladder wall. The left lateral portion of the bladder may then be "popped out" of its fascial envelope as though one were peeling

a grape. The fascial layers over the anterior surface of the bladder are then incised in a downward direction (toward the right lower quadrant of the bladder) in order to avoid injury to the anterior peritoneal fold. The bladder is partially emptied and the lower uterine segment on the left is then exposed by stripping the left superior lateral wall downward and thus exposing a triangular space formed by the posterior peritoneal fold, the partially removed bladder and the left rectus muscle. The fascia overlying the lower uterine segment in this triangular space is then incised. This fascia is the posterior sheath of the paravesical fascia and the anterior sheath of the periuterine fascia. It is thought that the use of an assistant's hands instead of abdominal retractors will lessen the incidence of perforation of the peritoneal fold or trauma to the bladder. The posterior peritoneal fold is retracted upward, the bladder downward to the right lower quadrant of the pelvis and the fascia laterally to the left. Incision in the uterus may be either longitudinal or transverse. All incisions should be made under direct observation. The infant in the vertex presentation is delivered by manual rotation to the occiput posterior position and application of low Simpson forceps. One ampule of pitocin is given intravenously after delivery of the baby. The placenta is removed manually if it does not spontaneously deliver after several minutes or cannot be expressed by gentle Credé. One ampule of ergotate is then given intramuscularly after delivery of the placenta. Sponge forceps or T clamps are applied to the edges of the uterine incision only after the placenta and membranes are completely expressed. The uterus is closed in two layers; the first layer is a row of interrupted sutures of No. 1 chromic catgut and the second is a continuous inverting Cushing suture of No. 1 chromic catgut. The bladder is refilled with a colored solution in order to test for possible lacerations. Two Penrose drains are inserted; one in the lower angle of the retrovesical area and the other in the left paravesical region.

The left rectus muscle is approximated in the midline to the opposite rectus muscle with interrupted sutures of oo plain catgut. The anterior rectus sheath is closed with interrupted figure-of-eight sutures of No. 1

Postoperative morbidity is defined as a rise in temperature to 100.4°F. on any two days following the first twenty-four hours, the temperature being taken every four hours. An analysis of eight cases in which

TABLE II  
NORTON EXTRA-PERITONEAL SECTION

	Average Labor in Hr.	Average Labor with Ruptured Membranes	Peritoneal Cavity Opened		Bladder Injured		Post-operative Morbidity		Stillborn or Neonatal Deaths		Babies over 3,800 Gm.		Maternal Deaths	
			No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Total cases 23	17 hr. 24 min.	6 hr. 8 min.	8	34.78	1	4.34	6	26.08	1	4.34	4	17.39	0	0
Total cases indicated 12 (52.17%)	37 hr. 8 min.	14 hr. 3 min.	3	13.05	1	4.34	2	8.69	1	4.34	3	13.05	0	0
Total cases not indicated 11 (47.83%)	1 hr. 56 min.	2 hr. 1 min.	5	21.73	0	0	4	17.39	0	0	1	4.35	0	0

chromic catgut. The subcutaneous tissue is closed with interrupted sutures of oo plain catgut and the skin with interrupted vertical mattress sutures of black silk. The Foley catheter is allowed to remain open with constant drainage for twenty-four hours and is then removed. The patient is catheterized thereafter every eight hours for residual urine until the residue is less than 50 cc. One ounce of 1:1,000 silver nitrate is instilled in the bladder every twenty-four hours during the period that residual catheterization is necessary.

The average operative time was one hour and twenty-five minutes; the shortest time was forty-six minutes and the longest time was two hours and nine minutes. Twenty-two sections were performed under spinal anesthesia, pontocaine, 20 mg. and 2 cc. of 10 per cent glucose. One section was done under cyclopropane anesthesia without any particular indication. The average fetal weight was 3,345 Gm.; the smallest baby was 2,466 Gm. and the largest, a stillborn, was 5,415 Gm. This baby was delivered by craniotomy and cleidotomy. (Case E. J.) The largest liveborn baby delivered was 4,082 Gm. (Table II.)

the peritoneal cavity was entered at the time of operation can be seen in Table III.

This incidence of postoperative morbidity exceeded the general postoperative morbidity for the entire twenty-three sections approximately 9 per cent.

TABLE III  
MORBIDITY WHEN PERITONEAL CAVITY WAS ENTERED

Peritoneal Cavity Invaded	No. Cases	No. with Morbidity	Percentage
Indicated extraperitoneal section	3	1	33.33
Not indicated extraperitoneal section	5	2	40
Total	8	3	37.50

TECHNICAL DIFFICULTIES

1. Three of the twenty-three sections were cases in which a low section had been done before. There was no particular difficulty encountered in these cases although in spite of more than ordinary care to avoid entering the peritoneal cavity in two of the three cases it was entered. This is 66.66 per cent as compared to the series

incidence of 34.78 per cent. In one case in which a previous low section had been performed a Norton section was tried but the adhesions between the anterior and posterior rectus sheaths and the rectus muscle were so dense that it was impossible to find a line of cleavage. A routine low section was then done.

2. Norton recommends the use of 5 Gm. of sulfanilamide powder in the retrovesical space. This was carried out in the first ten cases and one finds little difference in comparison to the next thirteen cases in which it was not done, provided the patient is placed on penicillin and oral sulfonamides. The procedure was abandoned following one case in which a severe episode of cyanosis occurred following the use of 4 Gm. of sulfanilamide in the retrovesical space. No case of paravesical abscess, cellulitis or sinus formation occurred. There was one stitch abscess and one superficial wound breakdown, both associated with faulty operative technic.

3. A Penrose drain was used in all cases except one. This case was an elective Norton section and the patient did well without evidence of infection. There was a considerable amount of serosanguineous drainage for the first forty-eight hours following operation. It would be extremely hazardous to omit the drain, at least in the indicated cases, and not provide this material with an avenue of escape. One of the objections to the Norton extraperitoneal section is the opportunity for soft tissue infection, particularly about the bladder. Consideration must be given to this point but it must be remembered that even in the low cervical section infected lochia may escape through the uterine wound into the soft tissues about the lower uterine segment below the peritoneal flap.

4. The uterovesical fold of peritoneum must be carefully inspected for lacerations and if found these should be sutured before the uterus is opened. Peritoneal contamination is theoretically much higher if this is not done. This is also a debatable point since a hole, even the size of that made by

an average-sized round needle, certainly affords an avenue of entry for bacteria into the peritoneal cavity.

5. The bladder must be distended with a colored solution such as methylene blue or indigo carmine to locate any locations.

6. One of the contraindications which might exist even in a case otherwise suited for the extraperitoneal type of section is that in which there is so much evident uterine inertia prior to delivery that it may be anticipated that the uterus will not contract properly following section. Cesarean hysterectomy would probably be indicated here.

#### CONCLUSION

The Norton type of paravesical extraperitoneal section offers to the obstetrician a method of abdominal delivery when the patient is infected and when there is no contraindication to the extraperitoneal approach such as (1) a very severely infected patient; (2) atonic uterus; (3) when sterilization is desired; (4) an adenxal condition such as an ovarian cyst producing dystocia.

Twenty-three case histories of patients operated upon at the University of Maryland Hospital during the past year ending March 1, 1948, following the technic of Dr. J. F. Norton of the Margaret Hague Maternity Hospital are presented. It is a simple operation and easily performed. This series, performed by many operators some of whom had very little operative experience, shows results that are neither too bad nor too good. This type of section should be done more often in order that one may honestly say "it is a good section and gives good results" or "it is a poor section and has too many dangers and complications." This clinic still does not know the answer and our results to date are presented for consideration as a step toward achieving a true picture of this operation.

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# RECENT DEVELOPMENTS IN WATER BALANCE\*

JOHN R. ROBINSON, M.D.

Diplomate, American Board of Surgery

*Kankakee, Illinois*

WITHIN the past decade the medical profession, especially the surgeon, has become particularly interested in body fluid changes associated with change in body health. We have gradually grown conscious of the fact that water and electrolyte balance influences the fundamental control mechanisms of life to no little degree. However, there are few fields in the modern armamentarium in which more general confusion exists in the mind of the average surgeon. This is chiefly because so little specific knowledge is available to aid in the establishment of principles upon which an objective choice of parenteral fluid agents might be made.

To date very little has been done to keep the general surgeon, not versed in intricate physiology, up to date on the modern concepts of fluid balance in terms applicable to the clinical patient seen in private practice. As a result the administration of parenteral fluids is carried out haphazardly by rule of thumb based on principles that have been found erroneous by their original proposers and long since discarded. This fact is responsible for the gross abuse of fluid administration particularly in the small general hospital.

For full understanding of the term water balance a few definitions and a few fundamental concepts must be considered: The first of these is the term extracellular fluid. (Fig. 1.) Extracellular fluid is composed of the plasma of the blood and the interstitial fluid (including lymph) which lies between the vascular compartment and the tissue cells. Functionally considered extracellular fluid is a particularly clear cut entity. Its physiologic rôle is as evident

as that of the nervous system. Extracellular fluid constitutes the immediate environment of the organism. It replaces, and in its essential features still closely resembles, the external environment (sea water) of the early forms of life. This

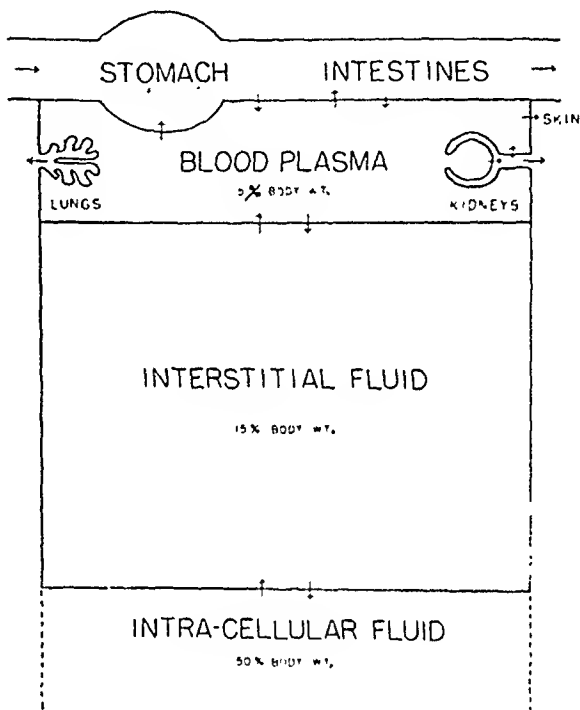


FIG. 1. Components of body fluid (after Gamble). aqueous medium which surrounds the tissue cells is the vehicle of transport of nutrient and waste materials. Beside this simple service it provides stability of physicochemical conditions, such as reaction in terms of hydrogen ion concentration, osmotic pressure and temperature. The values for these properties in cell fluid rest on the values at which they are held in the surrounding medium and the successful operation of vital processes requires an approximate constancy.<sup>9</sup>

The total quantity of extracellular fluid

\* Part of the work was done in the Department of Surgery, Wayne County General Hospital, Eloise, Mich., under the direction of Dr. C. A. Moyer.

is about 20 per cent of the body weight. As shown in the illustration one-quarter lies in the vascular compartment and three-quarters in the interstitial space. The volume of fluid in the tissue cells of the body is roughly 50 per cent of body weight, two and one-half times the volume of the surrounding medium. Incoming substances enter the plasma and it is this more rapidly circulating portion which is dealt with directly by the mechanisms of regulation. On the arterial side of the capillary bed fluid moves into the interstitial space under hydrostatic pressure produced by the work of the heart. On the venous side the osmotic differential provided by the plasma proteins is unopposed and sustains a return flow into the vascular compartment. The chemical composition of extracellular fluid is shown in Figure 2.

The second concept of importance in this problem is the make-up of this extracellular fluid. This may be divided into three parts: (1) the organic solutes of small molecular size (glucose, urea, creatinine, creatine, uric acid, amino acids; (2) the inorganic electrolytes; (3) the colloidal electrolytes or the organic proteins fractions. (Figure 2.) The chief concern of the clinician in the problems of water balance is with the inorganic electrolytes. For that reason the discussion will be confined to this group.

The third term which must be understood in order to quantitatively evaluate the electrolyte content of the extracellular fluid is the definition of milliequivalents per liter. This term is defined as the product obtained by dividing the mg. per liter by the atomic weight and multiplying by valence. In Figure 2 the electrolyte content of the extracellular fluid is measured by this means.

Disturbances in extracellular fluid equilibrium have been classified by Moyer<sup>13</sup> as: (1) Those of volume—(changes in relation of the extracellular salt water volume, base content of the body, to total body solids). This may be a deficit or excess,

that is, a base or sodium excess or deficit. (2) Those of composition—(departure from the normal electrolyte pattern of the extracellular fluids). This may be manifested as acidosis with an alkali deficit or bicarbonate deficit or as an alkalosis manifested by alkali or bicarbonate excess. (3) Those of distribution—(variations in the extracellular salt water volume of various tissues with the total extracellular salt water volume remaining constant, that is, variations in the transfer of extracellular salt water to the site of injury). This discussion will confine itself to volume changes only.

In Figure 3 the relative amounts of sodium, chloride and bicarbonate ions in the digestive secretions are shown. The sums of the other anion and cation components are indicated at the foot of their respective columns. These remainders are estimated from incomplete data but are probably near the values given. The total quantity of electrolyte in the secretions as shown by the height of the diagrams is closely the same as in blood plasma. Also, as in plasma, the large components of their structure are ( $\text{Na}^+$ ), ( $\text{Cl}^-$ ) and ( $\text{HCO}_3^-$ ). The diagrams make clear that failure of reabsorption of these secretions will withdraw water and total electrolyte from extracellular fluid in approximately plasma proportions.<sup>9</sup>

The important feature of the composition of these secretions from the point of view of structural change in extracellular fluid is this departure of the ( $\text{Na}^+$ ):( $\text{Cl}^-$ ) ratio from its plasma value. This is conspicuous in gastric juice and in pancreatic juice; in the other secretions the relative quantities of ( $\text{Na}^+$ ) and ( $\text{Cl}^-$ ) are roughly the same as in plasma. It is clear from the diagram of the gastric juice that loss of this secretion will cause a much more rapid withdrawal of ( $\text{Cl}^-$ ) than of ( $\text{Na}^+$ ) from plasma. It is probable that actually there is no sodium in the acid secretion from the digestive glands of the stomach. The small quantity shown in the diagram may be explained by ad-

mixture of the alkaline secretion of the gastric mucosa. The specimen from which these measurements were obtained was taken from an isolated pouch constructed in the pyloric antrum, in which region there is no secretion of the true juice. Ordinarily, the relative quantity of this secretion is small, but in the presence of

irritative conditions which provoke vomiting it becomes much larger and may reach a volume of about one-half that of gastric juice. There is, therefore, with vomiting a loss of (Na+) which may be approximately one-half the loss of (Cl-). Because of the dominating relationship of (Na+) to total ionic content of extracellular fluid

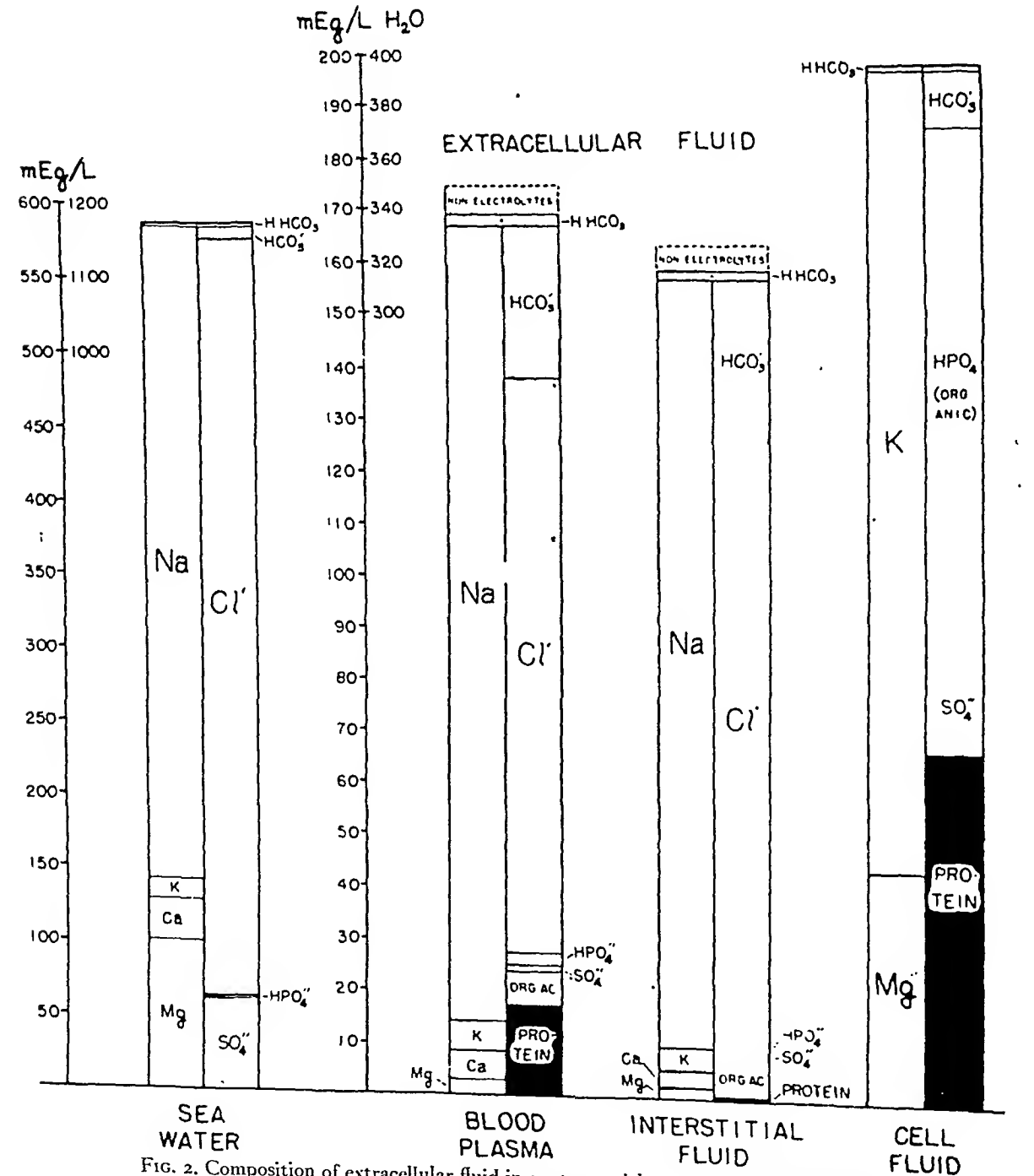


FIG. 2. Composition of extracellular fluid in contrast with sea water (after Gamble).



(Fig. 2), it is this loss of ( $\text{Na}^+$ ) which is significant in regard to extent of dehydration. Diarrhea causes loss of pancreatic juice which contains ( $\text{Na}^+$ ) in much larger excess than ( $\text{Cl}^-$ ). Gastric juice and all of the other intestinal secretions

salt to maintain satisfactory health. This view is supported by quantitative salt excretion tests. The actual amount of salt needed daily during a fasting state is still undetermined but from a surgical standpoint the, routine administration

### ELECTROLYTE COMPOSITION OF GASTRO-INTESTINAL SECRETIONS

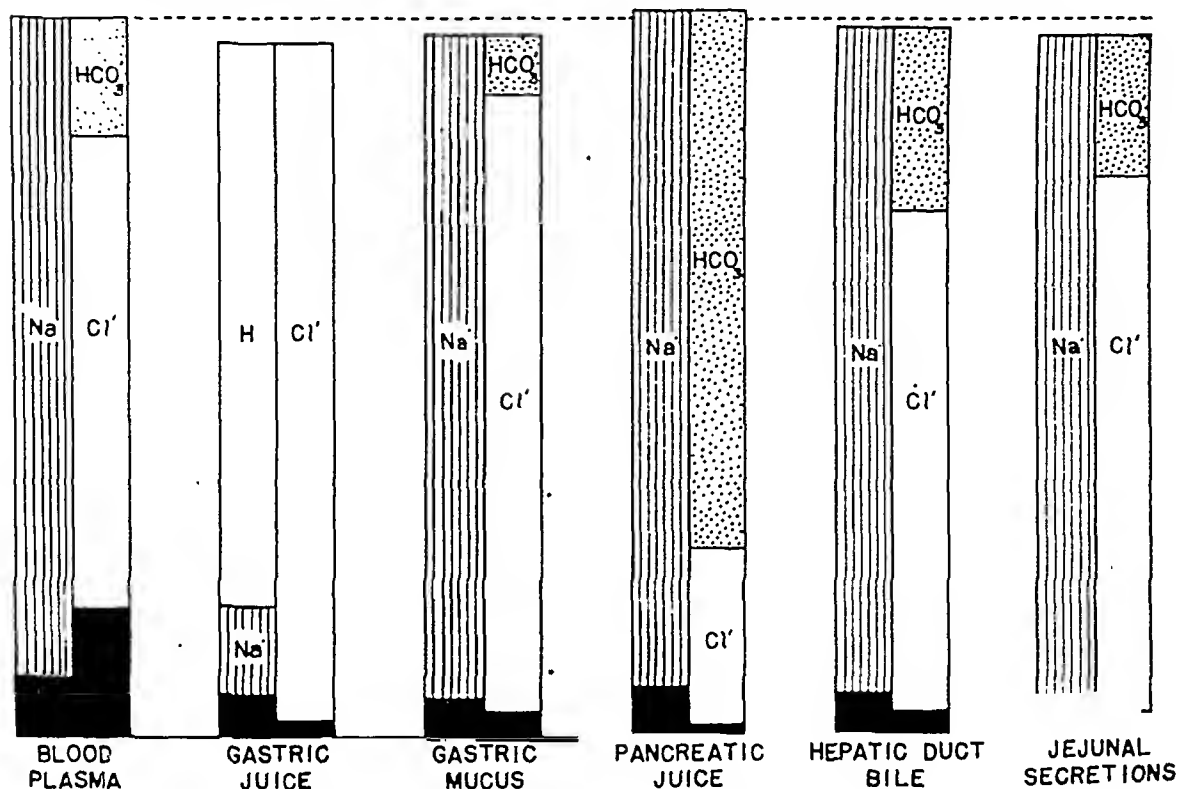


FIG. 3. Ionic composition of digestive secretions (after Gamble).

are, however, also exposed to loss so that ( $\text{Na}^+$ ) and ( $\text{Cl}^-$ ) are withdrawn in roughly their plasma proportions.<sup>9</sup>

Another important fact which must be kept in mind is that well persons, non-fasting, usually eat from 2 to 9 Gm. of salt daily.<sup>1</sup> This, however, is no reason for the sick man who is unable to eat to receive parenterally a similar amount. What is lost sight of by those who believe this is that a man on a 1 Gm. salt intake suffers no apparent harm providing his kidneys are functioning normally and he is not losing salt by diarrhea, vomiting, etc.

Many believe that habit rather than actual need governs salt intake and that a normal healthy man has more than enough

(parenteral) of 5 to 9 Gm. of salt daily when no abnormal loss is occurring is often detrimental and will hinder convalescence. In fact, Moyer<sup>13,14</sup> and others believe that a slight deficit of extracellular salt water is preferable to any excess even 5 to 9 Gm., particularly during the first few postoperative days. Certain evidence has been gathered to support this contention.

It can be easily demonstrated experimentally that salt solutions tend to collect in relatively greater quantities at sites of trauma than in normal areas.<sup>5</sup> An exteriorized loop of bowel or a large granulating wound will put forth far less transudate from the exposed surfaces if salt water is restricted. However, if given in excess,

the areas will swell and transudate will increase. The significance of this observation is at once obvious. The rate of healing varies inversely with the amount of edema present. As a result of edema in gastrointestinal surgery suture lines will swell with resulting leaks and delayed stomal function. Since following the principle of "slight deficit," far less trouble has been encountered following subtotal gastrectomy, resulting in an earlier removal of suction tubes.

Another site of collection for excess salt water is in the lungs. Postoperative pulmonary complications, particularly in the very young and the aged, will occur less often when the "slight deficit" principle is followed. In our experience pulmonary complications were reduced from 7 to 0.2 per cent by this means.

Experiments conducted on normal healthy adults have shown that a normal adult given a load of 0.9 per cent saline to 5 per cent of his body weight will retain approximately 40 to 50 per cent of the injected solution longer than twenty-four hours. This may be detected by weight studies. Postoperatively we are usually dealing with a patient who has suffered a certain amount of anoxia and hypotension during surgery, which in turn has resulted in some renal impairment. Because of this impairment, the retention of salt water injected parenterally will be higher, dependent upon the amount of impairment that has occurred and also on the length of time required for correction of this impairment.

If sodium chloride is given to young, healthy individuals, they will excrete it and the signs of salt retention will not appear even though 30 or more Gm. are ingested daily.<sup>16</sup> However, most ill patients are relatively incapable of excreting small excesses of salt even when given with large amounts of water. Coller,<sup>3,4</sup> Moyer<sup>13</sup> and others have shown experimentally that the retention of sodium is greatly increased in the immediate postoperative period and that it is not significantly

altered by increasing available water. Any individual who has suffered severe trauma or surgical procedures of large magnitude, aged patients, patients with poor vascular systems and those suffering from malnutrition do not handle salt water as the normal person does and they are relatively incapable of obtaining any free water from the isotonic saline solution.

Experiments previously mentioned well illustrated the means of accumulating an excess of salt water in the human body. For example, when a man was loaded to 5 per cent of his body weight with sodium chloride solution he was found to retain about one-half of this load for over twenty-four hours. During the period of loading the maximum excretion of urine was attained; this was much less than the rate of loading, being approximately 25 per cent. Because of this, the volume of salt retained in the body steadily increased while the urinary output remained relatively fixed. After administration was stopped the rate of urine decreased as the amount of saline in the body decreased. There was a relatively constant relationship between urinary output and the remaining load of saline. Because of this slow rate of excretion, large amounts (approximately 50 per cent in some cases) of the injected solution were retained over a twenty-four hour period. This retention of sodium chloride if cumulative leads to edema, fluid collections in the body, etc.

If these observations are illustrated by means of figures, the ease with which large accumulations of salt can occur is readily seen. For example, 4,000 cc. of saline are given the first day, 2,000 cc. excreted, 2,000 cc. remain; the second day the load would consist of 4,000 cc. given, plus 2,000 cc. remaining from the day before; applying the 50 per cent retention rule, 3,000 cc. will be left over at the end of this twenty-four-hour period, etc. From this it can readily be seen how such excesses occur and also the dangers of indiscriminate use of saline.

It is well known that a deficit of extra-

cellular salt water is much more easily corrected than an excess. To remove the accumulated excess salt water places an undue burden on an already impaired kidney and unless enough free water is available to allow for insensible loss and excretion of the excess salt, oliguria or anuria may result.<sup>5</sup> This free water may be extracted from the saline solution by the normal kidney by excretion of salt in higher concentration in urine than in the solution administered but is best supplied orally or parenterally.<sup>2,6,15</sup>

In an effort to complete the understanding of the subject a few moments spent examining the etiology and clinical picture of the various types of extracellular water imbalance will enable one to understand more fully the reasoning behind the choice of repair solutions. These types will be divided into four categories to facilitate discussion:

The first of these is extracellular salt deficit. This is seen when there is persistent loss of sodium from the body (extrarenally), that is, with vomiting, diarrhea or fistula. This condition rarely exists alone and is usually associated with water deficit or in states of acid-base imbalance. When water intake is low (below that lost through the kidney, skin and lung) during a simultaneous development of a salt water deficit, this first condition will develop. The signs and symptoms of this condition may be divided into three groups, with the forerunning statement that the more rapidly the deficit occurs the more severe are the symptoms: Group I are those cases in which a deficit of from 0 to 2 per cent of the body weight exists. In a previously healthy individual there will be no detectable clinical findings, but in a chronically ill older patient weakness, anorexia, apathy and reduced effective responses will be quite marked. Group II are those patients with from 3 to 5 per cent of the body weight deficit. They suffer from apathy, weakness, somnolence, anorexia, nausea, subnormal temperature, weak pulse, low blood pressure, reduced effective responses and a definitely sticky

skin. Group III are those who have over 5 per cent deficit. They are manifested by an increase in the severity of the aforementioned symptoms progressing to shock states and death as 40 per cent reduction in extracellular fluid is approached.

The second type of extracellular imbalances is an extracellular salt water deficit with water excess. This usually occurs when the sodium content of the extracellular fluid space has been lowered by actual loss and that which remains is diluted by water that is drunk or given by vein. Such a condition is frequently seen in various enteric fistulas, chronic diarrheas and granulating wounds in which the water loss has been replaced but the basic sodium loss had been neglected.

The third of the extracellular fluid imbalances is salt water excess with a relative water deficit. This is the common syndrome induced by overadministration of 0.9 per cent sodium chloride solution to the post-operative patient. The symptoms and signs are disorientation, anorexia, nausea, vomiting and oliguria with collection of fluid in the subcutaneous tissue, lungs and body cavity.

The fourth of these is salt water deficit with a water deficit. The cause of this condition is the loss of extracellular fluid at a more rapid rate than it can be acquired while no water is being taken or given. The clinical causes are those in which there is a loss of sodium such as vomiting, diarrhea or fistulous drainage. In these conditions the intake of water is at a slower rate than its insensible loss through the skin and lungs. The signs and symptoms of this condition are similar to those of extracellular salt water deficit alone plus oliguria and an increase in blood urea.

Laboratory signs of the aforementioned states vary with amount of deficit, rate of development and with cause of deficit. From this it can be seen at once that laboratory findings are dependent on so many variables that their actual worth is often questionable.<sup>1</sup>

The finding of "normal" blood solute or

red blood cell concentrations does not rule out the presence of an extracellular salt deficit. However, a diminution of the solute concentration ( $\text{Na}^+$  and  $\text{Cl}^-$ ) with an increase in the concentration of red blood cells (high hematocrit) is positive evidence that a relatively severe and rapidly developed extracellular salt water deficit exists. The relationship of the changes in solute and red blood cell concentrations to the salt water deficit are qualitative but usually not quantitative. Therefore, clinical examination often constitutes the best basis for ascertainment of the existence of salt water deficit.

Distributional shifts in extracellular fluid such as occur when salt water travels to a traumatized area and changes in composition of extracellular fluid are purposely omitted so as not to overcomplicate the discussion. Acid and base changes are also very important and will be discussed in a later paper.

Nevertheless, in administering fluids it is important that it be carried out in accordance with modern concepts of fluid balance. In a canvass of fifty of the smaller community hospitals in Illinois several common abuses were quite generally encountered in administration of fluids directly arising from a violation of such concepts.

The first of these was the overuse or overloading of the postoperative patient with normal saline solution. This was common practice in about 95 per cent of the hospitals reporting, and often the actual selection of the fluid was left to the discretion of a nurse rather than prescribed by the doctor in charge of the patient. The most commonly used solution in this No. one abuse was 5 per cent glucose in 0.9 per cent saline given in amounts of 2,000 to 4,000 cc. daily for several days postoperatively when no known source of salt water loss could be ascertained for the patient in question. The dangers of this procedure have been mentioned previously.

The second abuse was in failure to replace specific ionic losses by means of the

proper repair solutions. In most cases no matter whether the loss was from the stomach or ileum the repair solution was always 5 per cent glucose in 0.9 per cent sodium chloride.

The third abuse was use of parenteral fluids when oral fluids would have accomplished the same purpose. It has been the prevailing feeling in many places that the postoperative patient should not be given fluids by mouth. This is entirely erroneous. The only patients who should not receive oral fluids postoperatively are those who are nauseated or who have had gastrointestinal surgery. In this latter type of surgery one may desire to diminish peristalsis or avoid washing out chlorides through stomach suction tubes.

The fourth abuse was failure to provide enough free water for kidney function. The usual procedure in a patient who has a low urinary output is to use 25 or 50 per cent glucose to stimulate urinary outflow. This will only work when sufficient water and salt are available in the extracellular fluid. Often the cause of oliguria is a shortage of free water and as a result glucose will ordinarily not be effective and if it is effective it will only aggravate the deficit of water that is present. If an attempt is made to force urine flow in the presence of a salt deficit with 5 or 10 per cent glucose before the correction of the extracellular salt deficit, severe water intoxication may be induced and anuria results.

Hypertonic glucose solutions alone, while causing a temporary increase in urine by pulling water from the intracellular to the extracellular spaces, soon cause a reversal as the glucose passes into the cell because they draw water into the intracellular space producing a more acute extracellular water shortage in the extracellular space than existed before. To overcome this, 5 per cent or preferably 10 per cent glucose in distilled water should be administered as the source of free water for the body.

The fifth and last abuse noted in this survey was the basing of treatment of the

patient upon laboratory findings rather than the clinical picture. The pitfalls of this method have just been discussed.

In administration of fluids either parenterally or orally as repair solutions one must keep in mind the approximate losses which he is attempting to replace. These have been fairly accurately worked out by Coller et al.<sup>3</sup> Two factors must be taken into account: They are first, the actual fluid loss from urine, vomiting, drainage, suction or fistulas, and second, insensible fluid loss, chiefly from the skin and lungs as water vapor not containing salt. This latter factor may be roughly figured as totalling about 1,000 cc. per day.

Before discussing the reasons for use of the solutions in the mentioned examples let us preface it by saying again that it is always easier to correct a water deficit than to correct a water excess and that the clinical picture of the patient is the final measure of the amount of solution to be used. Whenever possible, repair solutions should be administered orally. The two that are most efficacious are: first, the hypotonic type composed of 3 Gm. of sodium chloride plus 1.5 Gm. of sodium bicarbonate dissolved in 1,000 cc. of water; second, the hypertonic type composed of 6 Gm. of sodium chloride plus 3 Gm. of sodium bicarbonate dissolved in 1,000 cc. of water. These solutions are not, as some contend, unpalatable and when chilled they make efficient replacement for extracellular fluid loss from such complications as intestinal fistulas, diarrhea, wound drainage, etc.

When unable to give fluids by mouth, we must resort to the parenteral route. The five stock repair solutions in use are as follows:

*Glucose Solutions in Distilled Water.* Most attention will be paid to the 5 per cent glucose, the so-called isotonic solution. This type of solution is indicated when one desires to replace acute water deficits in the face of normal extracellular fluid space components or nutritional losses. How much of these solutions are we to use? This is answered by the statement that enough

solution is used to return the patient as nearly as possible to normalcy. (Normal status mentally, physically and objectively.) Remembering that true dehydration cannot be treated by administration of dextrose alone, saline must be given for this correction if extracellular fluid is deficient. The other glucose solutions, 10 and 15 per cent, are used to provide food.

*Sodium Chloride Solutions.* It has been pointed out by Dr. Coller that saline solutions of 0.45 to 0.6 per cent are functionally more isotonic with tissue cells than the 0.9 per cent sodium chloride which is probably only isotonic with the red blood cells and, therefore, hypotonic saline solutions make better repair solutions than the so-called isotonic solution. If saline is being lost through suction, sweating or drainage etc., it is best replaced by giving milliequivalent for milliequivalent lost. While isotonic solutions of sodium chloride are widely used because of their ease of preparation and general availability, it has been known for years that isotonic solutions of sodium chloride are not entirely satisfactory for replacement of electrolytes and water. The work of Drs. Darrow,<sup>7,8</sup> Moyer<sup>12</sup> and Coller<sup>4</sup> et al. indicates that for the proper electrolyte replacement of extracellular fluid, sodium, chloride and bicarbonate or lactate ions in the infusion solution should be supplied in the same milliequivalent values as those ions are found in the normal extracellular fluid. Since the sodium chloride solution supplies only the sodium and the chloride, administration of this solution will supply an excess of the chloride radicle. This excess of chloride in the extracellular fluid space may produce severe disturbances in acid-base equilibrium and places an added load upon the kidney to eliminate the excess amount of chloride.

The solution, *isonate*,\* contains sodium bicarbonate in addition to sodium chloride thus maintaining the buffer value of the body fluids and reducing the work

\*A product of The Upjohn Company, Kalamazoo, Mich.

load of the kidney.<sup>8,16</sup> Use of such solutions containing sodium bicarbonate have long been known and recommended as a means of preserving the alkaline buffer of the blood and of counteracting potential or actual acidosis usually associated with dehydration due to loss of fluids following surgical procedures or loss of fluids due to burns, infection and diarrhea. The difficulties encountered in preparation of such solutions have until recently prevented their adoption for routine purposes. The solution isonate meets all the requirements aforementioned; it contains 0.644 Gm. sodium chloride, 0.252 Gm. sodium bicarbonate and 0.018 Gm. potassium chloride.<sup>8</sup>

*Hartmans Solution.* This is well known to the medical profession and performs a valuable service as a repair solution. It provides not only the electrolytes, sodium, potassium and chloride, but also racemic lactate which when converted to the bicarbonate ion acts as a buffer in the body fluids and therefore has an effect similar to isonate.<sup>18</sup> Hartmans solution and isonate solution provide the best repair solutions when intestinal fluids are being lost from enteric fistulas, biliary or pancreatic fistulas or long intestinal suction tubes.

*Sodium lactate solutions* ranging in strength from  $\frac{1}{6}$  to  $\frac{1}{2}$  molar have been found useful for their diuretic action as well as their buffering qualities. The diuresis is caused probably by the addition of an excessive sodium ion into the extracellular space.

In conclusion a few specific examples of the proper choice of repair solutions for a given patient are cited together with an explanation of the reasons for such choice.

The first example is that of a postoperative patient in the first twenty-four hours following hysterectomy who is not debilitated or dehydrated prior to the time of operation; the patient is not nauseated and is able to start taking fluids by mouth within a few hours after the operation. She should not have more than 1 liter of glucose solution to supply her water needs for the day. This may be given during the

operation. In this example the average normal patient needs only a sufficient amount of water to cover the insensible loss during the first twenty-four hours after the operation.

In the second example we have a similar postoperative patient who is nauseated and vomiting following return from the operating room. A rough measurement of this patient's actual loss by vomiting should be made and replacement should be carried out using a glucose solution in 0.6 per cent saline in amounts equivalent to the amount lost in vomiting. Since this patient is losing some sodium and considerable chloride from the stomach vomitus, obviously the only needed replacement is sodium chloride plus insensible loss coverage. This is best replaced as we have previously mentioned by hypotonic saline in glucose solution.

Our third example is postoperative subtotal gastric resection during the first twenty-four hours following surgery. A suction tube is working during this period. The patient with this type of surgery should receive an amount of hypotonic saline (0.6 per cent) equivalent to that lost by the suction drainage. The remainder needed to cover the insensible loss plus the urinary output of the day before should be in the form of 5 or 10 per cent glucose in water. One must remember, of course, that if the patient has received blood in the operating room in the excess of that lost during the operation then the need of saline solution will be proportionately reduced. We must in this type of case take care to replace only that amount of sodium chloride which is lost as any excess will accumulate in the areas of trauma, that is the suture lines, and will by means of edema delay function or possibly cause actual leakage.

The last example is that of a patient with a newly working ileostomy. This patient should receive as nearly as possible an amount of Hartmans or isonate solution equivalent to the amount of drainage from the ileostomy. If this same patient, how-

ever, is able to take fluids by mouth, part of this may be replaced through the use of sodium bicarbonate-sodium chloride solution just mentioned. (Sodium chloride, 3 Gm. + sodium bicarbonate,  $1\frac{1}{2}$  Gm. in 1 L. water.)

Intestinal contents are basic in reaction and therefore use of the buffered bicarbonate chloride solutions with excess sodium come the closest to replacing the actual loss of any of the repair solutions available.

#### SUMMARY

An attempt has been made herein to point out with only the barest minimum of fundamental physiologic facts the elementary considerations which must be kept in mind when administering fluids parenterally. The methods of fluid administration now commonly employed by the smaller community general hospital were discussed together with reasons for believing that some of these are outmoded. Corrections were suggested by the use of specific examples in an effort to further clarify the problem. Relation of extracellular sodium to intracellular potassium has purposely been omitted so as not to complicate the discussion.

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# EXPERIENCE WITH REFRIGERATION ANESTHESIA\*

## SIX SUPRACONDYLAR AMPUTATIONS FOR ARTERIOSCLEROTIC GANGRENE

J. BERKELEY GORDON, M.D.

*Marlboro, New Jersey*

THE following brief communication is in no sense to be considered as original work and any credit for the development of either the theory or technique of refrigeration anesthesia is specifically disclaimed. It is proposed merely to cite the experience of one individual with a technique which seems particularly applicable to the type of material with which we are constantly dealing, with the hope that others will be able to utilize the method for the benefit of their own patients. While we are all concerned predominately with psychiatric problems, and it is fitting that our programs should be largely concerned with psychopathology and problems of hospital administration, it may not be amiss to interject an occasional note on physical medicine since it is all too easy for us to become overspecialized in the realm of deranged thought and to lose contact more and more with the world of general medicine and surgery. Moreover, since the admission rate for senile and arteriosclerotic patients is constantly mounting and this class of patients is definitely hampering our efforts to give adequate therapy to the more hopeful functional psychoses, it is obvious that geriatric surgery in our state hospitals is increasing and that we must seek out all possible means of giving relief to these elderly patients. Many of them are afflicted with a loathsome and foul-smelling foot or leg which makes life a burden.

Preliminary work on the effects of reduced temperature on both healthy and morbid human tissue has been done for the past ten years by a number of workers who have demonstrated that cold instead

of heat is often the therapy of choice and that temperature reduction will inhibit pain, edema, infection, shock, toxic absorption and tissue devitalization. Thus, Temple Fay and associates at Temple University Medical School have demonstrated the inhibitory and destructive effects of moderate degrees of cold on normal embryonic tissues and on primitive, poorly differentiated neoplastic cells which resemble normal embryonic forms. Such cells of low differentiation survive within a very narrow temperature range and succumb readily to cold to be replaced by stronger and more specialized cells. Fay was able to cause the regression and even the complete disappearance of sloughing breast carcinomas considered to be inoperable, extensive epitheliomas of the vulva and other surface locations where it was possible to apply cracked ice directly to the affected part over long periods and reduce the temperature of the cells to about 40°F. Spectacular results have been demonstrated in patients considered to be beyond the hope of further surgery as the primitive carcinoma cells die and are replaced by healthy granulation tissue and stratified squamous epithelium. Unfortunately a method of applying this technique to malignancies of internal organs has not been developed. Hibernation of the patient with the whole body surrounded by cracked ice for weeks at a time has also been used in an effort to prolong life and retard the process in those with extensive malignancies of the abdomen. Frederick M. Allen and Lyman Weeks Crossman of the New York City Hospital have produced a mass of evidence and data concerning use

\* Presented at the quarterly combined staff meeting of the New Jersey State Hospitals, held at the Marlboro State Hospital, October 15, 1946.



of cold and its application to surgery, treatment of burns, prevention of surgical and traumatic shock, treatment of thromboses and emboli of the extremities and preservation of living tissues.

The present paper is concerned entirely with one limited phase of this work, namely, use of cold in the production of anesthesia for amputation of gangrenous legs in senile arteriosclerotics. Prior to adoption of refrigeration anesthesia the writer had used spinal and, occasionally, inhalation anesthesia for this type of operation. Crossman's refrigeration anesthesia technic was tried with such satisfactory results that it is now considered the anesthesia of choice for this operation. The principle involved is simple; within physiologic limits, the conductivity of nerves is directly proportional to temperature. Lowering temperature decreases conductivity. All protoplasmic activity is reduced as temperature is lowered so that cold tissues cannot respond by physical or chemical reactions to any stimulus. Amputations done with this type of anesthesia are completely without shock; there is no interference with the patient's dietary regimen (many of them are diabetic as well as arteriosclerotic), meals are eaten both before and after amputation, use of narcotics is minimized or abolished and there is minimal disturbance of the routine of those patients who stand changes badly. They have no pain whatever during the operation and are often completely unaware that an operation has been performed. All of our amputations have been done with cracked ice as the refrigeration agent. This is the most simple and probably the safest method although there are various electrically operated cooling devices that are entirely successful. The only advantage of the electrical apparatus over ice for operative anesthesia lies in its convenience and avoidance of mess. As the cost of the complete equipment is about \$700.00, hospital executives may be dubious of such an expenditure for this purpose unless the number of amputations

is particularly large. No harm can be caused from ice alone as it is impossible to cause frostbite of the tissues with ice. It is important, however, not to allow some zealous assistant to add salt to the ice. If this is done with the mistaken idea of hastening or improving the anesthesia, frostbite with gangrene of the wound edges and delayed healing will result.

An efficient tourniquet is essential for without complete occlusion of both arterial and venous circulations the patient will become chilled and uncomfortable and the temperature of the leg will not be properly reduced. Allen and Crossman have demonstrated repeatedly that the narrow, soft, rubber tourniquet is innocuous and that the important thing is not to injure the tunica intima of the blood vessels with a hard surface such as a cord. We have not seen a thrombosis or embolus, delayed healing or other evidences of vascular injury in our small series. It is interesting to see the popliteal artery begin to pulsate and the wound begin to ooze immediately after the vessels have been secured and the tourniquet removed. A tourniquet of  $\frac{1}{2}$  inch gum rubber tubing is used in two layers, one superimposed on the other, secured by two strong clamps and placed about 6 inches above the site of the amputation.

The surgeon may use whatever technic of amputation he prefers as the method of operation is irrelevant. Dr. Crossman prefers the circular guillotine type of low thigh amputation, disarticulating the knee with the scalpel and discarding the leg before transecting the femur. The patients in the six cases reported herein have been treated by the same technic, namely, a modified Carden's amputation with a medium anterior flap through the patella tendon, cutting out the patella when the flap is reflected. A very short posterior flap is used severing the hamstring tendons near their insertion, clamping, cutting and ligating the vessels and nerves in the popliteal space, injecting the nerves with 95 per cent alcohol and transecting the

femur from 1 to 3 inches above the condyles. The tourniquet is then removed by an unsterile, circulating nurse. Any new bleeding points are ligated and the sharp edges of the femur are rounded off with the raspator. Sulfanilamide powder is sprinkled over the raw surface and the wound is closed by through and through vertical mattress sutures of silkworm gut. No drains are used and no sutures are put in the muscles. The entire operation usually takes about thirty minutes. There is no necessity for haste, however, as the anesthesia lasts well. The only important difference in the surgical nurse's procedure is that cold saline solutions for rinses are used instead of warm liquids. Refrigeration of the stump is continued by three ice bags for forty-eight hours postoperatively so that sensation and protoplasmic activity return gradually. Sutures are removed on the fourteenth day. Wound healing is delayed by both pre- and postoperative refrigeration so that earlier removal of sutures may result in gaping of the edges. Usually no opiates are needed either pre- or postoperatively although a barbiturate is usually given to prevent the patient from attempting to stand up during the first postoperative night. There is no change in the dietary regimen. The patient may be gotten out of bed into a chair or wheel chair within twenty-four to forty-eight hours and any indicated medication required for the general condition may be continued. If ice bags are applied to the site of the tourniquet for one-half hour before its application, the cutaneous nerves are numbed and the patient has no discomfort when the tourniquet is applied.

Operation may be scheduled at any time convenient to the team as long as the refrigeration process is started sufficiently far in advance to cause anesthesia. Ordinarily from two to two and one-half hours of refrigeration are required for a low or mid-thigh amputation. Excessively fat patients may require three hours. However, if for any reason the operation is delayed, the refrigeration may be continued indefi-

nitely and no ill effects will ensue. Our refrigeration technic and preoperative orders, which are essentially those of Crossman, are as follows: local preparation of the thigh and leg; (scrub and shave the knee and popliteal areas; apply clean

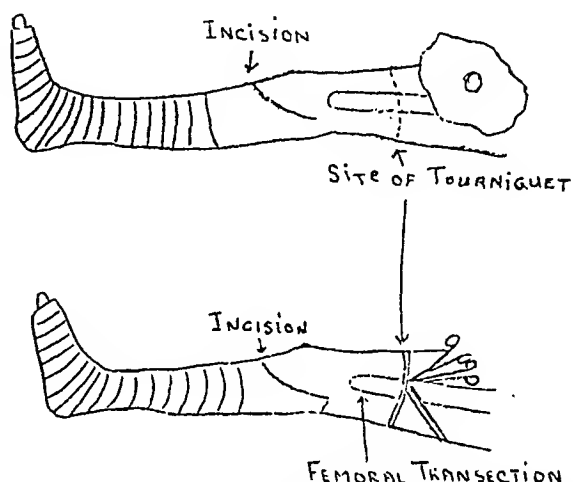


FIG. 1. Drawing showing locations of tourniquet and incision.

bandage on the gangrenous parts). Allow breakfast and lunch as usual and elevate the head of the bed. Neumbutal, 3 gr., should be given orally at 10 A.M. Apply three ice bags (one posterior and two medial) to the site of the tourniquet (Hunter's canal). Remove the ice bags at 10:30 A.M. and apply the tourniquet (two superimposed layers of rubber tubing secured by two Kelly clamps laterally). Refrigerate immediately with finely cracked ice from the toes to well above the tourniquet. Wrap the leg in a rubber sheet funneled into a bucket on the floor at the foot of the bed. Continue refrigeration adding more cracked ice as needed to keep the entire leg covered. Proceed to the operating room at 1 P.M. without removing the ice. The ice is left on until the surgical team is scrubbed and ready to proceed with the operation. The ice is then removed by the operating room orderly who slides the rubber sheet and ice into a laundry hamper. The leg is then prepared and draped in the usual manner and the amputation is performed. Refrigeration of the

TABLE I

Name	Date of Operation	Age	Race and Color	Sex	Indications	Procedure	Surgical Results	Late Results	Cause of Death
M. B. admitted June 17, 1881 L. S.	February 14, 1944	80	American negro	F	Wet gangrene of right foot and leg	Right supracondylar amputation	Uneventful recovery	Died February 15, 1945	Bronchopneumonia; arteriosclerotic cardiovascular disease
R. P.	March 7, 1945	69	White; native born; Danish parentage	M	Wet gangrene of right foot	Right supracondylar amputation	Uneventful recovery	Died April 13, 1945	Bronchopneumonia; arteriosclerotic cardiovascular disease
R. S.	July 5, 1945	62	White; Italian birth and parentage	M	Wet gangrene of left foot and leg; diabetes mellitus	Left supracondylar amputation	Uneventful recovery	Died September 16, 1945	Cerebral hemorrhage; arteriosclerotic cardiovascular disease
P. M.	March 18, 1946	77	White; native born; unknown parentage	M	Wet gangrene of left foot; (recent amputation of right thigh)	Left supracondylar amputation	Uneventful recovery	Died May 6, 1946	Bronchopneumonia; arteriosclerotic cardiovascular disease
C. D.	June 24, 1946	83	White; Italian birth and parentage	M	Wet gangrene of right foot and leg	Right supracondylar amputation	Uneventful recovery	Living and well October 15, 1946	
	September 11, 1946	Unknown (about 70)	White; Lithuanian birth and parentage	M	Wet gangrene of the left foot	Left supracondylar amputation	Uneventful recovery	Living and well October 15, 1946	

stump with three ice bags is continued for forty-eight hours postoperatively.

#### SUMMARY

Of the six cases mentioned in Table I there were five men and one woman. The ages ranged from sixty-two to eighty-three, with an average age of 73.5 years. Of the six amputations three were performed on the right thigh and three on the left. One of the six had diabetes mellitus. It is interesting to note that the patient, Case IV, on whom a left-sided amputation was done, had had a right supracondylar amputation for the same condition before coming to this hospital. It is also interesting that M. B., Case I, entered the Trenton State Hospital on June 17, 1881, at the age of seventeen and had been in various state hospitals of New Jersey continuously almost for sixty-four years when she finally died.

Prior to the introduction of refrigeration anesthesia the operative mortality for this type of operation at the New York City Hospital ranged from 55 to 80 per cent, deaths being due chiefly to shock, infection and embolism. In this series the operative mortality was zero. All of the patients made normal, uneventful convalescences. The last two patients were still living, approximately four months and one month postoperatively.

#### CONCLUSION

While this series is too small to justify any conclusions in itself, it is believed that these six cases added to the experience of other surgeons tend to confirm and reinforce the conclusions that refrigeration anesthesia is a highly satisfactory and safe technic in amputations of the lower extremity for senile arteriosclerotic gangrene.



# ACUTE DISEASE OF THE PORTAL VEIN

C. N. GESSLER, M.D.

*Nashville, Tennessee*

DISEASES in which there is little hope for cure constantly challenge the medical profession. As such, acute disease of the portal vein merits study although there is little to be done about it except to make heroic attempts to avoid it. Portal vein thrombosis occurs most often in conditions in which blood is stagnant in the portal vein. Portal vein infection complicates severe peritoneal infections; appendiceal infections precede it more often than anything else. The incidence of acute portal vein disease is not determined for it is of such a nature that it is rarely diagnosed until the patient is moribund. It is impossible to say how many patients may have a small infection or thrombus in the portal vein which may disappear and leave no residual symptoms. Undoubtedly the specific drug therapy available to us in the past few years has lowered the possibility of portal vein infection and perhaps has minimized what might have been a fatal complication.

Thrombosis of a vessel implies partial or complete obstruction of the vessel by clotted blood; infection of a vessel implies invasion of micro-organisms to or into the vessel. A combination of the two processes is a result when the obstructing material is infectious. If the thrombus originates in the vessel wall, the disease is called thrombophlebitis; if the thrombus originates from a blood stream disorder, the disease is called phlebothrombosis; if the material inside the vein is frankly purulent, pyemia exists and if this is in the portal vein, it is called pylephlebitis. In some instances production of the process may involve all three of the previously mentioned conditions for example when an abscess erodes into the vessel. In these cases one calls the process thrombophlebitis or pylephlebitis depending on the degree of infection of the invading material.

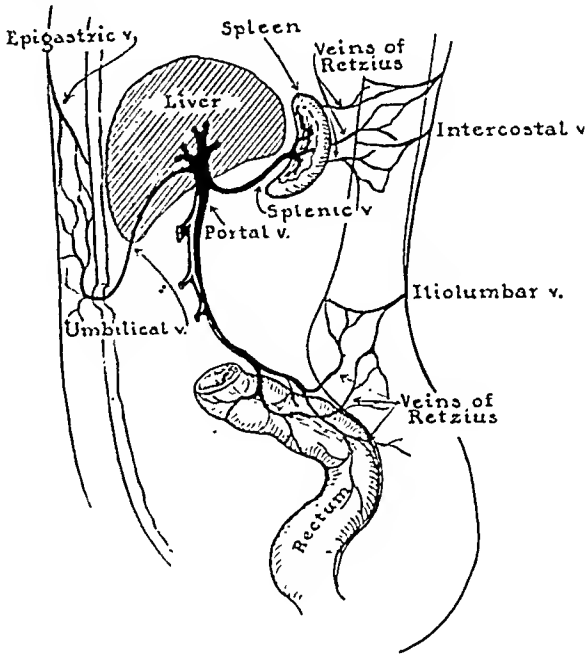
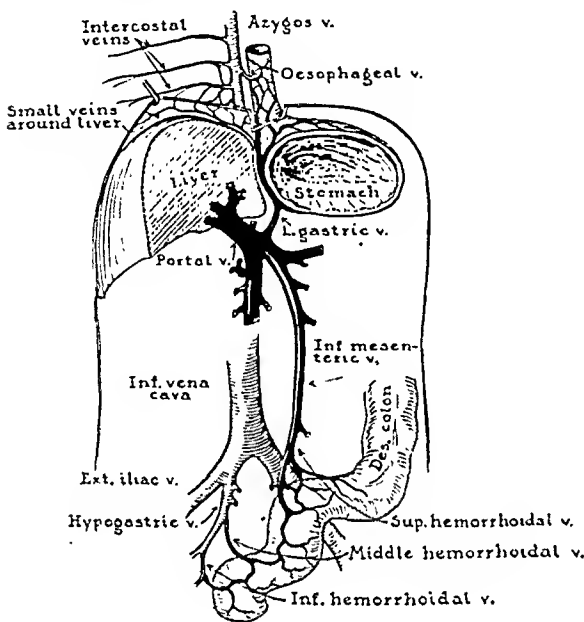
The production of thrombi is initiated by three major factors: slowing of the circulation, trauma to the intima and increased tendency to clotting. Frequently a combination of these processes is present. In stagnant blood the heavier cellular elements of the blood settle to the bottom while the plasma circulates on top. Within the plasma are the platelet cells; these have a tendency to stick to any raw or injured surface encountered; therefore, if the circulation through an injured vessel is slow, clot formation may occur. Vascular injuries caused by trauma, stretching, bruising or infection are dangerous in that thrombi may form at the injured spot. Infection of tissues near blood vessels frequently reflects the general inflammatory reaction into the wall of the blood vessel and thus thrombi are formed. Increased tendency to clotting may arise from several causes, most of which depend on the balance of fibrinogen, calcium and prothrombin. Calcium and prothrombin react together to form fibrin on which a clot is built. Thrombokinase is a catalyst to the formation of thrombin; heparin counteracts the effect of thrombokinase. Thrombokinase is liberated into the blood stream after any tissue injury, particularly muscle injury; in massive injuries a great deal of thrombokinase may be present so that it overbalances the heparin in the body and thereby coagulability of the blood is enhanced.

When conditions exist for the production of thrombi or infection inside a vessel, propagation of the process is the natural course. Once there is a thrombus there will be eddying or stagnation of blood immediately beyond the thrombus and here further clotting may easily take place. From time to time small bits of the thrombus may break off and be carried by the blood stream to lodge at some place

down the line. If these materials carry bacteria, small abscesses are formed at the final resting place.

When these processes take place in a peripheral vessel, the net result to the entire organism is that of dysfunction of

neal organs of the abdomen and pelvis and extremities are drained by the caval system. Inferior vena cava arises at the junction of the two iliac veins and ascends to the heart in close approximation to the abdominal aorta. The portal system con-



FIGS. 1 and 2. Natural anastomotic shunts by which blood may by-pass the liver in portal obstruction.

the part affected. When these processes take place in the portal vein, the intestinal tract and the liver are the parts affected; the drainage of blood from the intestinal tract is interfered with and the liver does not receive its major supply of blood. If it is remembered that the liver is the first collector of blood which has been absorbing materials from the intestinal tract and the liver has several paramount functions of assimilation and detoxification the importance of this obstruction will be appreciated.

A review of the anatomy involved will facilitate an understanding of the problem. It will be remembered that the blood below the diaphragm returns to the heart through two systems: the portal system and the inferior vena caval system. In general, the alimentary tube and the intraperitoneal organs are drained by the portal system; the abdominal wall, retroperito-

sists of the portal vein and its tributaries; the portal vein is a short trunk formed by the confluence of the superior mesenteric and splenic veins; the smaller radicles come from the intraperitoneal structures. The portal vein branches out in the liver to deliver blood to all parts of the liver. In close approximation to the branches of the portal vein within the liver are branches of the hepatic artery and from these two systems, the portal vein and the hepatic artery, the liver receives its blood. The hepatic vein picks up the blood in the liver and returns it to the inferior vena cava.

When there is portal vein obstruction, hypertension of the portal system develops; an attempt is then made to compensate for this by development of the following collateral circulation (Figs. 1 and 2): (1) Left gastric veins of the portal system anastomose to epigastric veins of the caval system; (2) superior hemorrhoidal veins

of the portal system anastomose to inferior and middle hemorrhoidal veins of the caval system; (3) small veins around the liver (veins of Sappey) of the portal system anastomose to intercostal and diaphragmatic veins of the caval system; (4) para-

the collateral circulation which slowly becomes efficient. It is true that the liver has another source by which it may receive blood, the hepatic artery, and it is possible that blood may be delivered to the liver by this route for the various detoxification

TABLE 1

ACUTE PORTAL VEIN DISEASE AT VANDERBILT UNIVERSITY HOSPITAL FROM 1933 TO 1946

	Age	Race	Sex	Clinical Diagnosis	Autopsy Finding (Portal Vein)	Portal Vein Disease is Secondary to	Condition of Liver	Result	Autopsy
1	63	W	F	Duodenal ulcer	Thrombosis	?	Congestion	Died	Yes
2	57	W	M	Mesenteric thrombosis	Thrombosis	?	Hemochromatosis	Died	Yes
3	10	W	M	Banti's disease	Thrombosis	Cirrhosis	Cirrhosis	Died	Yes
4	53	W	F	Cholecystitis; liver abscess	Thrombosis	Abscess	Abscess	Died	Yes
5	39	W	M	Cirrhosis	Thrombosis	Cirrhosis	Cirrhosis	Died	Yes
6	12	W	F	?	Pylephlebitis	Appendicitis	Abscess	Died	No
7	15	W	F	Appendicitis; pylephlebitis	Pylephlebitis	Appendicitis	Abscess	Died	Yes
8	29	W	M	Liver abscess	Pylephlebitis	Appendicitis	Abscess	Died	Yes
9	54	W	F	Pylephlebitis	Pylephlebitis	Appendicitis	.....	Died	No
10	16	W	M	Appendicitis; pylephlebitis	Pylephlebitis	Appendicitis	Abscess	Died	Yes
11	29	W	M	Liver malignancy	Obstruction	Hypernephroma	Malignancy	Died	No
12	33	W	M	Traumatic condition of the abdomen	Obstruction	Retroperitoneal hematoma	Normal	Cured	

umbilical veins of the portal system anastomose to epigastric veins of the caval system; (5) veins of Retzius drain retroperitoneal portions of abdominal viscera.

It should be pointed out that this collateral system is developed only when there is gradual onset of portal obstruction as in cirrhosis of the liver or malignancies encroaching on the vein.

In cirrhosis of the liver there has been a great deal of difference of opinion as to exactly what causes death. Beckman does not believe it is from hepatic insufficiency but rather from the results of portal hypertension; he suggests that if relief can be obtained from portal hypertension the problem is not so great. Many observers have noticed that in cirrhosis the patient does badly early in the disease but then in many cases does very well for a few months; they postulate that this remission of symptoms is due to the functioning of

and assimilation processes accomplished in the liver.

This concept of cirrhosis has been presented in order to compare the problem of acute portal vein obstruction. When there is rapid development of portal hypertension, there is probably little chance for compensation by collateral circulation for the collateral veins are small when first called upon for this purpose. Blood does not reach the liver from the intestinal tract; the various liver functions do not take place and the resultant effect on the body is that of hepatic insufficiency. Another difference between the problem of thrombophlebitis of the portal vein and of cirrhosis is that the obstruction may be close to the intestinal tract so that no blood can escape from the part of the intestinal tract involved, thereby producing wet gangrene of the tissues affected. Furthermore, the thrombus may be propo-

gated so that finally liver thrombi, or if infected, liver abscesses are present.

Thrombosis and infection of the portal vein are not frequent. (Table I.) In thirteen years at Vanderbilt Hospital there were only twelve cases of acute disease of the portal vein. Five of these were thrombosis of the portal vein, five were pylephlebitis and two were extrinsic obstructing lesions. In no case was thrombosis accurately diagnosed before death; in three of the five cases pylephlebitis was suspected before death but no satisfactory treatment was devised. In only one of the twelve cases did the patient survive and this was in a case of retroperitoneal hematoma which was reduced by operative manipulation and reduced in time to relieve the portal hypertension. Thus, there was one cure in twelve cases of acute portal vein disease, or a mortality rate of 91.66 per cent. There was a mortality rate of 100 per cent in pylephlebitis of the portal vein and a mortality rate of 100 per cent in thrombosis of the portal vein. The finality of these facts should be tempered with the possibility that mild degrees of these diseases may occur and then resolve so that we are never aware of their presence.

In the five cases of thrombosis of the portal vein cirrhosis of the liver was primary in two cases, purulent gallbladder disease and liver abscess was primary in one case and no demonstrable cause was found in two cases. Apparently then, in three cases of five at least, stagnation of blood due to obstruction in the liver was responsible for the formation of thrombi in the portal vein. Acute gangrenous appendicitis was primary in all five cases of pylephlebitis. In most of these cases the autopsy report included statements such as: "when the portal vein was incised, thin creamy purulent fluid ran out freely," indicating that in these cases an abscess had literally developed in the vein. Whether or not this originally was a thrombus which had become necrotic or whether the appendiceal abscess eroded into the vein directly is speculative.

The best treatment against phlebotrombosis, thrombophlebitis or pylephlebitis of the portal vein is prevention. Increased attention to the factors just mentioned may help to prevent its occurrence. The factors about which something can be done are the following: reduction in severity of infection by the judicious and prophylactic use of chemotherapy; reduction in operative trauma of vessels; reduction in operative trauma of tissues so that less thrombokinase will be liberated; use of heparin to counteract thrombokinase when thrombosis is feared; drainage of abscess which might erode into vessel walls; removal of extrinsic pressure on the vessel which might cause stagnation of blood and the general use of good surgical judgment.

When the process is present, however, it is of no immediate value to discuss prevention. A discussion of the treatment of this problem involves first a discussion of the accurate diagnosis of the problem. In studying the records of twelve patients with acute portal vein disease at Vanderbilt Hospital it was obvious that in the few cases in which the disease was suspected it was not apparent until shortly before death and as a result an analysis was made to find ways in which an early diagnosis could be made. (Table II.) In all of these cases there was an elevation of the leukocyte count and ascites and jaundice were present; in the only two cases in which a van den Bergh test was made the result was biphasic; serum proteins were reduced in two cases with the reduction primarily in the serum albumin. Blood cultures were inconstantly positive but were positive in two of the five patients with pylephlebitis.

In any case in which there is rapid production of ascites, jaundice, leukocytosis, febrile reaction, reduced serum albumin and evidence of hepatic failure one should think of acute obstruction of the portal vein. When these symptoms appear following acute intraperitoneal infection, particularly following acute gangrenous appendicitis, one should think of pylephlebitis.



In pylephlebitis there is no known treatment once the disease is well established. Multiple liver abscesses form early when the portal vein contains pus. The only thing one can hope for is to establish treatment early enough in the disease to

portal vein or possibly in thrombi arising due to cirrhosis of the liver. Several operations have been devised to attempt to by-pass the liver, including various operations attempting to promote anastomosis between veins of the abdominal contents

TABLE II

LABORATORY STUDIES IN TWELVE CASES OF ACUTE PORTAL VEIN DISEASE AT VANDERBILT UNIVERSITY HOSPITAL

Ascites	Blood Culture	W.B.C.	Serum Proteins			Icterus Index	Van Den Bergh
			Total	Albumin	Globulin		
800 cc.....		25,000	7.1	4.9	2.1		
Yes.....		16,500					
Yes.....		23,000					
2,000 cc.....	B. coli	9,800	...	...	...	60	
Yes.....		12,000					
1,500 cc.....	Negative	11,000	4.6	2.4	2.2		
Yes.....	B. coli	19,000	...	...	...	26	Biphasic
800 cc.....	Strep.	25,000					
		17,500	5.9	3.5	2.4	25	Biphasic
300 cc.....		15,000					
Yes.....		12,000					
Yes.....		15,000					

abort it. The use of penicillin, streptomycin, sulfonamides or a combination of them is obviously important. The drug will probably reach the portal system fastest and in greatest concentration if absorbed through the gastrointestinal tract. If this tract already has no venous circulation, then it will be difficult to reach the portal system by this or by any other method other than direct intubation; and it will require courage to subject a patient, already moribund, to drainage of the portal vein with perhaps resection of a portion of the gastrointestinal tract which will already be gangrenous both from loss of venous circulation and from the original infection.

If the obstructing mass in the portal system is high enough in the portal system, that is in the portal vein itself, the condition could be relieved by ligation of the portal vein and the establishment of collateral circulation for blood to by-pass the liver. This approach would be feasible in extrinsic obstructing lesions near the

and the epigastric veins of the abdominal wall; none of these have been generally successful. The Eck-fistula, in which a side-to-side anastomosis of the portal vein and inferior vena cava was made with subsequent ligation of the portal vein, has not been successful because of the inevitable production of thrombi at the site of the anastomosis. Whipple, however, reports doing five Eck-fistula operations recently using a non-suture technic with vitallium tubes with good results. Blake-more and Lord report a portocaval anastomosis technic of uniting the ends of splenic and left renal veins after performing a splenectomy and left nephrectomy. All of these operations have been performed for cirrhosis. It may be that this operation will also be useful in high thrombosis of the portal vein.

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SHUMACKER, JR. et al. review the effects of dicumarol and other anticoagulants in performing surgery on aneurysms, fistulas, etc., and conclude that reparative surgical procedures upon peripheral arteries can be done safely when the patient is under the full effects of such anticoagulant therapy. (*Richard A. Leonardo, M.D.*)

# HYPERPARATHYROIDISM\*

## AN ANALYSIS OF TEN CASES WITH SPECIAL REFERENCE TO EARLIER DIAGNOSIS

LLOYD B. BURK, JR., M.D.

*Ann Arbor, Michigan*

ALMOST fifteen years have passed since Albright and his associates first presented their work which gave the medical profession the physiologic basis for understanding hyperparathyroidism.<sup>1</sup> Since then many authors have noted the early symptoms of this disease,<sup>1-6</sup> but the diagnosis is still most frequently made after serious skeletal complications or irreparable renal damage have occurred. The insidious nature of hyperparathyroidism and its varied manifestations often make the diagnosis a difficult one. Albright has repeatedly suggested certain criteria for suspecting the disease.<sup>1,8</sup> X-ray and laboratory aids for confirming the diagnosis of hyperparathyroidism have been re-emphasized many times. Only by recognizing the early symptoms of this disease can the diagnosis be suspected and the confirmatory measures be employed. The debilitating and frequently irreversible complications demand early recognition of the disease.

Ten cases of hyperparathyroidism that have been diagnosed and in which the patients have been operated upon at the University Hospital are presented with emphasis on those factors which could lead to an earlier recognition of this condition. The first case of proved hyperparathyroidism in this clinic was seen in 1933. This diagnosis was not made again for seven years, but since 1940 nine other cases have been recognized and the diagnosis proved by operation and pathologic study. Six of these cases were diagnosed at the University Hospital and four were referred with the diagnosis already made.

### CASE REPORTS

If the diagnosis of hyperparathyroidism is to be made in the early phases of the

disease, it is necessary to emphasize the symptoms which will cause the physician to suspect its presence. For this reason details of histories of these patients are presented to demonstrate the symptoms which occur relatively early in the course of hyperparathyroidism. The essential x-ray and laboratory data for all of the cases are summarized in the accompanying tables.

CASE I. A forty-seven year old housewife was admitted to the University Hospital December 6, 1933. Three years prior to admission she developed "rheumatism" characterized by painful, swollen ankles. This was transitory except for slight residual tenderness. Six months prior to admission she had an attack of pain in the left chest occurring on change of position. There was also associated nocturia six times nightly, burning on urination and cloudy urine. The patient was in bed for seven weeks during which time these symptoms apparently abated. Three weeks prior to admission she began having a slightly productive cough, pain in the lateral aspects of the chest and night sweats. The pain was exaggerated by coughing, lying down, turning and walking and was relieved by sitting in a chair. There was also some epigastric discomfort related to meals. Occasional ankle edema with dependency had occurred for six months. Weight loss during the year had amounted to 30 pounds.

Physical examination pointed to an anemia, left lower lobe pulmonary disease and aeromegaly. The latter diagnosis was based on osseous enlargement of ankles, feet, wrists and hands with thick tapering fingers, moderate prognathism and mild bitemporal hemianopsia. Subsequent x-rays showed large frontal sinuses and a large sella turcica. The pulmonary disease proved to be bronchiectasis and the anemia was hypochromic, microcytic in type. The evidence of pituitary dysfunction and anemia lead to skeletal x-rays which showed generalized skeletal demineralization. Calcium and phos-

\* From the Department of Surgery, University of Michigan Hospital, Ann Arbor, Mich.

phorus determinations suggested hyperparathyroidism.

The patient refused operation and she was discharged on a medical regimen. She felt fairly well for several months and then the symptoms returned. Three weeks before her second admission the pain in the ribs became greatly exaggerated and there was increase in weakness and pain in the back. Examination, x-ray and chemistry studies were essentially the same as on the first admission. A parathyroid tumor was removed at operation.

*Comment.* The symptoms of this patient for the most part were not very suggestive of hyperparathyroidism and the diagnosis was established only after tenacious endeavor to explain the multiple symptoms and signs. In retrospect the chest pain may have been related to changes in the ribs. The history of painful, swollen ankles and occasional ankle edema seemed rather insignificant yet these were due to the parathyroid dysfunction. The anemia had no known basis. There was no history of chronic hemorrhage and so it was assumed that it was the result of hematopoietic interference. Hyperparathyroidism is well recognized as being one of many causes of obscure secondary anemia.<sup>1</sup> The association of acromegaly with hyperparathyroidism is a rarity.<sup>7</sup> The exact relationship between the two diseases is uncertain.

**CASE II.** This patient was a twenty-five year old man who began having generalized aching in the lower extremities two years before admission. Six months later he had a sudden onset of intermittent renal colic. This was followed by hematuria and passage of calculi on several occasions. Additional renal calculi were reported as having been visible in the roentgenogram. The patient had several mild episodes of urinary tract infection after this but these were reported as responding satisfactorily to sulfonamide therapy. However, a roentgenogram of the abdomen revealed that the renal calculi were increasing in size and cystic areas were present in the pelvis and upper femora. After calcium and phosphorus determinations were obtained, the diagnosis of hyperparathyroidism was made. The patient

was sent to the University Hospital where a parathyroid tumor was removed at operation.

*Comment.* It should be stressed that while roentgen evidence of skeletal involvement was present in this case, it need not be present in hyperparathyroidism.<sup>8</sup> The renal involvement in hyperparathyroidism is well known and it should be emphasized that the renal symptoms are of extreme importance. Cope<sup>4</sup> reports that 55 per cent of seventy-eight cases had renal calculi without any skeletal changes being present and that the diagnosis has been achieved by performing calcium and phosphorus determinations routinely in all cases with renal calculi. The exact incidence of hyperparathyroidism in patients who have renal calculi is not known but it is Cope's impression that it may be 10 to 15 per cent.

**CASE III.** Ten months before admission this fifty-six year old woman had a giant cell tumor removed from the right maxilla and a month later another was removed from the left mandible. She was then asymptomatic until five months prior to admission when the right leg became "lame" without any history of trauma. This symptom continued unchanged. Six weeks before admission she jarred her right arm while going downstairs. It became quite tender and there was some pain on motion. X-rays revealed marked skeletal demineralization and multiple bone cysts; there were fractures of the right humerus and right femur. A left renal calculus was present but had produced no symptoms. The diagnosis of hyperparathyroidism was confirmed by removal of a parathyroid adenoma at operation.

*Comment.* The giant cell tumor referred to by the patient was probably an osteoclastoma though we have no proof of this. However, it is pertinent to regard cystic deformities of the maxilla and mandible as possibly resulting from parathyroid hyperfunction until proved otherwise.<sup>1-3</sup> The development of persistent pain in the extremities occurred five months prior to fracture. This should be borne in mind as an important symptom. The renal calculi produced no symptoms until one and a half years postoperatively. She then had

two episodes of colic and passed a small calculus. Retrograde pyelograms revealed bilateral renal calculi. The serum calcium at this time was 11.8 mg. per cent and the phosphorus was 3.0 mg. per cent.

**CASE IV.** A twenty-six year old woman first noted a dull pain in the left hip two and one-half years before admission. The pain was associated with a limp; these symptoms were continuous and gradually progressive. One year before admission she suffered a fall with a resultant fracture of the left patella which was treated by internal wire fixation. Following this she always walked with a crutch or a cane. There was increasing fatigue and some edema of the feet, both of which were exaggerated by weight-bearing. Six months prior to admission the pain became worse and persisted to admission. Three months before her admission she had given birth to a normal infant. A 20 pound weight loss had occurred during the year. X-rays showed cystic lesions in the pelvis and ribs interpreted by another radiologist as probable metastases from a Ewing's tumor. Our studies lead to the diagnosis of hyperparathyroidism and a parathyroid tumor was excised.

*Comment.* This is such a typical history of the skeletal type of hyperparathyroidism that attention should be called to the onset of persistent pain in the lower extremities a year and a half prior to fracture and two and one-half years before the diagnosis was made. Certainly all cystic areas in bone, especially in the long bones, pelvis, ribs and patella should be regarded with suspicion until calcium and phosphorus determinations are made to rule out this disease.<sup>1-4</sup>

**CASE V.** This patient was a seventeen year old white girl. For two years she had noticed progressive weakness and fatigue. A year later she began to have a persistent aching type of pain in her knees, legs and arms. Seven weeks before admission she stumbled on the school steps fracturing the left humerus. X-ray examination showed a pathologic fracture. Four days later the patient had the onset of right flank and abdominal pain, diarrhea, several episodes of vomiting and a temperature of 99.5 to 100.0°F. Pain and fever subsided but

the diarrhea persisted. While in bed, she incurred a fracture through a cystic area of the right femur. Extensive studies carried out by her physician established a tentative diagnosis of hyperparathyroidism and renal tuberculosis. There were no urinary symptoms except daytime frequency every two hours and nocturia twice nightly. The diagnosis of bilateral renal tuberculosis was confirmed. There was no associated pulmonary disease. At operation a parathyroid adenoma was found and excised.

*Comment.* This patient had persistent pain in the lower extremities for a full year before fracture occurred. Had this been recognized as an important symptom and the disease diagnosed and treated at this point, fracture might not have resulted. In various types of chronic renal disease enlargement of the parathyroid glands<sup>9</sup> occurs. When renal impairment is the cause of secondary parathyroid hyperplasia, usually three or four of the glands are enlarged. In this patient a solitary parathyroid adenoma was found at operation rather than diffuse hyperplasia. It is believed that the tuberculosis was not related to the parathyroid disorder. The diffuse calcification of the renal parenchyma which was present on the roentgenogram may have been due either to hyperparathyroidism or renal tuberculosis. Perhaps both were contributory in this patient.

**CASE VI.** This patient was a thirty-one year old man. A case summary has been previously reported.<sup>10</sup> However, it is included here in order to emphasize the characteristic progression of symptoms. His chief complaint was that of "sore knees" which had been present for a year. He described the insidious onset of aching in both knees followed by aching in the elbows eight months later. These symptoms were continuous and progressive. One month before admission he was pushing a car and experienced severe pain over the left tibial tubercle. A week later the left leg suddenly became very weak and he fell to the ground. There was swelling of the knee and the patient reported that fluid was aspirated from the joint spaces by his physician. Subsequent studies revealed generalized skeletal demineralization, multiple bone cysts, fractures through cystic

areas in two ribs and nephrocalcinosis. A parathyroid adenoma was removed at operation and a fragment of the tumor was transplanted between the strap muscles of the neck. Two years later the patient returned with a recurrence of all manifestations of hyperparathyroidism and at operation a parathyroid adenoma was found at the site of the graft. Neither tumor was considered malignant on microscopic examination. Nearly two years later he again returned with recurrent symptoms and at this third operation the tumor was found at the site of the primary adenoma as well as at the site of the graft. The tumor invaded the thyroid gland, muscle and other soft tissues of the neck. Microscopic examination by pathologists revealed cellular changes compatible with a diagnosis of carcinoma of the parathyroid gland. No evidence of metastases have appeared to the present time.

*Comment.* The symptoms of this patient re-emphasize the importance of persistent skeletal pain as one of the earliest manifestations of the disease. Invasive or metastatic qualities of parathyroid tumors are rare.<sup>12,13</sup> When they do occur, the prognosis, of course, is poor.

**CASE VII.** This was a twenty-four year old woman. Five months before admission she had mild transient aching of the left knee on weight-bearing. This subsided but a few weeks later aching in the right knee developed which, though mild, was persistently present on weight-bearing. Two weeks prior to admission she stepped from a curb on the right foot and had a severe pain in the right hip. She fell to the ground and was unable to get up. She was taken to a hospital where x-rays demonstrated a fracture through a cyst of the right femur. She was referred to the University Hospital two weeks after injury where an initial diagnosis of hyperparathyroidism was confirmed and a parathyroid tumor was removed at operation.

*Comment.* This patient had persistent aching in the lower extremities five months before a fracture was incurred. But again, diagnosis was not made until a fracture directed attention to the extremity.

**CASE VIII.** A fifty-three year old white female had the onset of her illness five years

before admission. At that time she had suffered a spontaneous fracture of the left patella and she was told it was due to a "cyst." Internal fixation was performed and recovery was apparently uneventful. Four years later she began to have aching in the left knee and this was followed over a period of several weeks by the onset of persistent aching in the right knee, the hips, shoulders, elbows and hands. The pain was exaggerated by damp weather and exertion and relieved by salicylates. These symptoms were progressive and the right hip became quite painful on motion during the six months just prior to admission. There was progressive weakness and a weight loss of 30 pounds. A week before admission she became bedridden. On examination she had painful limitation of motion of all the above joints and an initial diagnosis of a mixed type of arthritis was made. However, subsequent studies revealed the probability of parathyroid hyperfunction. A parathyroid tumor was found imbedded in the left side of an adenomatous thyroid gland.

*Comment.* In this case there was a history of both a bone cyst and persistent pain in the extremities. The latter was so generalized and was in association with swelling, tenderness and pain on motion of multiple joints that it was confused with arthritis. The patient had advanced skeletal changes as evidenced by spontaneous fracture of humerus and femur while turning in bed during the postoperative period.

**CASE IX.** This thirty year old man had an episode of renal colic at the age of eighteen. At twenty-three this recurred and retrograde pyelograms made by his physician revealed and dislodged a ureteral calculus. Four years before admission he began having symptoms of hypoglycemia and during a two-day period of unconsciousness a blood sugar was reported to have been 23 mg. per cent. Six months after his first hypoglycemic attack he had a laparotomy and an islet cell tumor was removed from the pancreas. Two months later he had a right nephrolithotomy. Two years prior to admission he was in an auto accident at which time he suffered a skull fracture with a resulting left hemiplegia. He had constant fatigue unrelieved by rest for many years but following

the accident it seemed to be more marked. A little less than a year had passed before he was again hospitalized at which time he had a right nephrectomy for calculus disease. Four months before admission he was placed on oral prostigmin for "spastic symptoms." During the month preceding his entrance to the University Hospital he had three episodes of occipital headache, marked weakness and fatigue, twitching of the left shoulder and arm, projectile vomiting and vertigo. The past history also revealed five fractures since the age of thirteen. All of them were due to considerable trauma, the last one occurring at the time of the auto accident.

Physical examination revealed a left frontoparietal skull defect and spastic paralysis of the left upper and lower extremities. No tumor could be palpated in the neck. No skeletal symptoms were present and the x-rays of the bones were negative. Repeated blood sugar tests and a glucose tolerance curve demonstrated the absence of hypoglycemia. Because of a persistently elevated calcium level and the operative loss of one kidney, exploration of the parathyroids was performed and an adenoma removed.

*Comment.* The history of the pancreatic tumor and injuries from the auto accident interjected into a long history of renal calculi was at first misleading. However, this case belongs in the category of parathyroid adenomas that have only renal symptoms. The fractures that this patient had all followed trauma of sufficient degree so that none of them could be termed spontaneous or pathologic fractures. The roentgenograms of the skeletal system failed to reveal any generalized demineralization or any bone cysts. There was no history of skeletal pain, tenderness or deformity. Only the kidneys had suffered from the parathyroid dysfunction and it would seem that the calcium-phosphorus imbalance could probably have been detected many years previously. Because it was not discovered, this patient has only one kidney at the age of thirty.

*CASE X.* This forty-eight year old white man had his first symptom ten years prior to admission when he noted that his upper front teeth

were loose. Following the administration of calcium, the teeth became firmly imbedded. Three years later he had symptoms of renal calculi which were subsequently relieved by the passage of four small stones. Twenty-one months prior to admission he had the onset of fatigue, weakness, malaise and drowsiness. At this time he began having muscle and bone pain of both thighs. These symptoms were ascribed to badly infected teeth and the latter were extracted five months later. Because of difficulty in the fitting of dentures he consulted an oral surgeon who discovered a right maxillary tumor. This was removed and the pathologic study revealed it to be a giant cell tumor. The pain in the lower extremities was somewhat relieved following the removal of the tumor but a year later recurred and was persistent. The latter became so severe in the following months that crutches were employed until finally he became completely bedridden. Two months before admission, while holding a quart jar of water, he suffered a fracture of the right humerus and one month later, while testing the strength in his hand, an extensor tendon was avulsed from its insertion. Also during this latter period his ribs became tender and swollen.

On examination the significant physical findings were a non-tender, soft mass approximately  $1\frac{1}{2}$  by  $2\frac{1}{2}$  cm. in the lateral aspect of the left lobe of the thyroid, marked dorsal kyphosis, palpable deformity of the right humerus and right radius, and bilateral costovertebral tenderness. The x-ray and laboratory studies confirmed the diagnosis and a parathyroid tumor was removed. This patient developed an uncontrolled hypoparathyroid state postoperatively and died on his twentieth postoperative day of intercurrent infection.

*Comment.* This patient's prolonged illness and subsequent death would probably have been avoided if the disease had been recognized at one of several points in its course. The passage of renal calculi should have suggested hyperparathyroidism. Later the symptoms of hypotonia and persistent skeletal pain were a basis for suspicion. More recently, the removal of a giant cell tumor of the maxilla was further evidence of possible parathyroid hyperfunction. The spontaneous fracture which occurred was in an area of a bone cyst and a second

fracture occurred in the left femur during the postoperative period.

COMMENTS

The most important symptoms for early recognition of this disease are recorded in Table 1.

TABLE 1  
INITIAL SIGNIFICANT SYMPTOMS IN  
HYPERPARATHYROIDISM

Case	Initial Significant Symptom	Interval between First Symptom and Diagnosis
I	Painful, swollen ankles	3 yr.
II	Renal colic, hematuria, passage of calculi	1½ yr.
III	Giant cell tumor, right maxilla	10 mo.
IV	Persistent dull pain, left hip	2½ yr.
V	Fatigue and weakness; persistent aching pain in all extremities	2 yr.
VI	Persistent aching pain of knees and elbows	1 yr.
VII	Persistent aching pain of right knee	4 mo.
VIII	Spontaneous fracture of left patella through a bone cyst	5 yr.
IX	Renal colic	12 yr.
X	Renal colic; passage of calculi	7 yr.

TABLE II  
HYPERPARATHYROIDISM—SKELETAL STATUS

Case	Pain and Tenderness of Muscles and Joints*	Swelling of Joints*	Deformity*	Skeletal demineralization	Bone Cysts	Fracture	Anemia
I	+	+	+	+	0	0	+
II	+	0	+	+	+	0	0
III	+	0	+	+	+	+	+
IV	+	0	0	+	+	+	+
V	+	0	0	+	+	+	+
VI	+	+	+	+	+	0	0
VII	+	0	0	+	+	+	0
VIII	+	+	+	+	+	+	+
IX	0	0	0	0	0	+	+
X	+	+	+	+	+	+	0
Total	9	4	6	9	8	7	5

\* Symptoms not associated with fracture.

† Severe trauma.

*Skeletal pain and tenderness* was present in all but one of these cases (Table II) and in five of them it was the initial symptom. The pain was usually described as an aching

type of pain in the lower extremities but was occasionally present in the upper extremities and back. In two cases pain was associated with weight-bearing. It should be especially emphasized that though the pain was not incapacitating in the early phases, it was *persistent*. Thus, the complaint of persistent aching pain in the extremities is very important in recognizing the early stages of the skeletal type of hyperparathyroidism.

*Renal calculi* have long been a criterion for suspicion of hyperparathyroidism. Cope<sup>4</sup> has shown that parathyroid hyperfunction frequently produces renal calculi without producing skeletal changes. In three of our patients the initial symptoms of the disease were those of renal calculi and in Case IX these were the only symptoms for nearly twelve years. One other patient with renal calculi had no symptoms referable to this. Three other patients had nephrocalcinosis without stones in the calyces or pelvis. (Table III.) In Case X only microscopic nephrocalcinosis was present.

*Spontaneous fracture* occurred as an initial symptom in only the one case but it occurred five years before the diagnosis of hyperparathyroidism was made and it was known that the fracture occurred through a bone cyst. Six other patients had suffered one or more fractures through cystic areas at variable periods before admission. (Table II.)

Tumor of the maxilla was the first symptom to occur in one case (Table I) though another patient had this deformity appear during the undiagnosed course of the disease. (Table II.) Osteoclastomas of the maxilla or mandible, as in these two cases, may be reported by the pathologist as giant cell tumors. Osteoclastomas are not uncommonly a manifestation of hyperparathyroidism.<sup>1,2</sup>

*Hypotonia.* That hypercalcemia results in muscular weakness, ease of fatigue, constipation and other gastrointestinal disturbances has been known for many years. These symptoms cannot be considered of



great diagnostic import although they have a real physiologic basis. If such symptoms appear in a formerly active person, the possibility of hyperparathyroidism should not be wholly forgotten. In Case v fatigue and weakness were the

## BLOOD CHEMISTRY

A discussion of early diagnosis in hyperparathyroidism would not be complete without denoting the variation in calcium and phosphorus levels. It has been repeatedly demonstrated that calcium levels are

TABLE III  
HYPERPARATHYROIDISM—RENAL STATUS

Case	Symptoms of Calculi	Nocturia, Polyuria	Nephrolithiasis	Nephrocalcinosis	Decreased Renal Function	Infection	Sulkowitch Test
I	o	+	o	o	+	o	
II	+	o	+	o	++	+	
III	o	o	o	+	.....	+	
IV	o	o	o	o	.....	o	
V	o	+	o	+	++	+	
VI	o	+	o	+	++	+	++++
VII	o	o	o	+	.....	o	++++
VIII	o	+	o	o	++++	o	++++
IX	+	o	+	o	++	o	Negative
X	+	o	+	o	+++	o	+++
Totals	3	4	3	4	7	4	4

initial symptoms and all but one patient complained of some manifestation of hypotonia for long periods in the course of the disease. (Table iv.)

*Secondary anemia* may result because of a proliferation of the reticular cells of the

not necessarily markedly elevated in the disease, especially in the early phases.<sup>1</sup> Two of our patients had only slight elevation of the serum calcium. (Table v.) In Case I levels varied from 12.0 to 13.0 mg. per cent and in Case iv levels varied from 11.3 to

TABLE IV  
HYPERPARATHYROIDISM—EVIDENCES OF HYPOTONIA

Case	Lassitude, Weakness	Weight Loss	Gastrointestinal Disturbances	Objective Signs of Hypotonia
I	+	+	+	+
II	o	o	o	?
III	+	+	+	?
IV	+	+	+	?
V	+	?	+	+
VI	+	+	+	+
VII	+	+	o	+
VIII	+	+	+	?
IX	+	o	+	?
X	+	+	o	+
Totals	9	7	7	5

bone marrow which replaces the hematopoietic elements.<sup>1</sup> This was present in five cases. (Table II.)

TABLE V  
HYPERPARATHYROIDISM—BLOOD CHEMISTRY

Case	Calcium (mg. per cent)		Phosphorus (mg. per cent)		Alkaline Phosphatase (Bodansky U.)	
	Min.	Max.	Min.	Max.	Min.	Max.
I	12.0	13.0	2.2	3.2		
II	....	15.7	...	3.6	....	4.5
III	....	16.4	...	3.8		
IV	11.3	12.1	2.5	2.9	13.3	14.8
V	15.4	16.1	2.9	3.1	....	9.4
VI	....	15.8	....	4.0	....	19.5
VII	14.4	16.1	2.5	2.9	16.9	18.8
VIII	13.4	13.8	4.0	4.1	4.3	9.7
IX	12.0	13.9	2.4	2.8	3.9	7.6
X	....	14.1	....	4.0	....	10.0

12.1 mg. per cent. A single determination which is borderline does not rule out

hyperparathyroidism; when the symptoms so indicate, several determinations should be made. Serum protein determinations should always be included as one of the routine laboratory studies when hyperparathyroidism is suspected. If the serum proteins are low, a normal value for calcium may indicate hyperparathyroidism.<sup>4</sup>

Phosphorus levels will be relatively low unless renal insufficiency results in phosphate retention.<sup>8</sup> The many normal or slightly elevated values recorded in Table v can be accounted for on the basis of decreased renal function.

Alkaline phosphatase levels are of diagnostic value only if skeletal disease is advanced. Albright<sup>1</sup> is of the opinion that this determination is an index of osteoblastic activity.

#### SUMMARY

The case histories of ten patients who have had the diagnosis of hyperparathyroidism confirmed by surgical removal of a parathyroid adenoma have been reviewed. From these cases it is apparent that an early diagnosis of this entity requires that the physician become "parathyroid conscious." The earliest symptoms may be wholly related to the skeletal system, to the muscular system or to the renal system without striking overlap. A positive diagnosis made early in the patient's disease will prevent most of

the crippling sequelae of long-standing hyperparathyroidism.

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# WOUNDS OF THE HEART AND PERICARDIUM\*

PHILIP CRASTNOPOL, M.D., EMANUEL GOLDBERGER, M.D.,  
RAYMOND M. MARCUS, M.D. AND LESTER OSTROVE, M.D.

*New York, New York*

THE treatment of wounds of the heart and pericardium has changed considerably from the days when cardiac surgery was considered hopeless and heroic to the present when reports of operative interference are no longer rare. The mortality rate has been greatly reduced, due in no small part to the more frequent diagnosis of wounds of the heart and pericardium. Perforations of the heart such as the type caused by bullets and lacerations of the intrapericardial vessels will result in rapid exitus before effective therapy can be instituted. Our findings, as well as those in the literature, indicate that when the patient arrives at the hospital alive, no matter how critically ill, he may be saved. We are presenting, herein, four cases of stab wounds of the chest with pericardial and myocardial involvement, of which three were treated conservatively and one was treated by surgery. The electrocardiogram played an important part in the early diagnosis of these cases.

## DIAGNOSIS

*Significance of Early ECG's.* Much has been written previously about the diagnosis of penetrating wounds of the heart and pericardium. Anyone receiving a lacerating wound over the precordial region must be suspected of having sustained cardiac trauma. This is especially true when the symptoms of shock are out of all proportion to the amount of blood lost<sup>1</sup> and when a hemopneumothorax has been excluded. In the presence of hemothorax, the possibility of a wound which has pierced both pericardium and pleura with bleeding from one cavity into the other must be borne in mind.

Griswold and Maguire<sup>1</sup> mention Beck's triad of acute cardiac compression: (1) falling arterial pressure; (2) rising venous pressure and (3) small, quiet heart. These, together with the physical findings of rapid, paradoxical pulse, low pulse pressure, distention of venous circulation and distant, muffled heart sounds speak of tamponade. Fluoroscopy in doubtful cases bears out the fact that cardiac activity is reduced, and may further demonstrate intrapericardial fluid. X-ray, on the other hand, is not necessarily of much help<sup>2</sup> since it will usually show no abnormality of heart size inasmuch as only 100 to 200 cc. of blood will cause tamponade.

These patients are usually in such deep shock that they appear to be in extremis. It is difficult then to move them around for adequate fluoroscopic and roentgenologic examination. We have found the electrocardiogram of great help in verifying early the presence of injury to the heart and pericardium by changes indicative of pericarditis, hemopericardium or myocardial injury. In addition to the three standard leads, augmented unipolar extremity leads and multiple unipolar precordial leads<sup>3,25</sup> were taken because it has been shown that these are of value in detecting evidence of myocardial injury when the standard leads are normal. The augmented unipolar leads were taken from the left arm (left arm lead), the right arm (right arm lead) and the left leg (left leg lead). The multiple precordial leads were taken as follows: lead  $v_1$ , precordial electrode on the fourth intercostal space just to the right of the sternum; lead  $v_2$  precordial electrode on the fourth interspace just to the left of the sternum; lead  $v_3$

\* From the Second Surgical and the Cardiological Services, Lincoln Hospital, New York, N. Y.

mid-way between leads  $v_2$  and  $v_4$  which is the precordial electrode on the fifth intercostal space at the left of the mid-clavicular line; lead  $v_5$ , electrode on the left anterior axillary line at the level of  $v_4$ ; lead  $v_6$ , electrode on the left mid-axillary line at the level of the lead  $v_4$ .

Many investigators have pointed out<sup>4,5,6</sup> that pericardial effusion in itself does not cause electrocardiographic changes, and the presence of changes in the RS-T segments and T waves is a sign of injury to the superficial layer of the myocardium just beneath the pericardium. In cases of penetrating wounds of the heart the presence of RS-T and T changes, however, does not necessarily indicate that the heart muscle itself has been injured by trauma because a pericardial effusion or a hemo-pericardium can serve to irritate the superficial layers of the heart. The deep wide abnormal Q waves that occur after myocardial infarction do not appear after penetrating wounds of the heart unless one of the larger coronary arteries is severed as a result of the accident. Solovay, Rice and Solovay<sup>7</sup> point out that weeks or months after operation T wave changes become more pronounced and then revert to normal.

#### MANAGEMENT

In the past there has been considerable divergence of opinion as to the management of these cases. Bigger predicates the type of treatment on the nature of the injury. In 1932<sup>8</sup> he divided his cases into three classifications: (1) Pericardial injury alone or pericardial and heart injury without penetration into a chamber division or coronary vessels. These may be treated conservatively; (2) penetration into a chamber or coronary vessel division. Operation is usually indicated; (3) severe injuries with immediate death.

In 1939 Bigger<sup>9</sup> divided his cases into four groups and treated them accordingly: (1) Free communication between the pericardium and pleura but only slight or moderate hemorrhage. These are treated

conservatively. (2) Tamponade present, but following venoclysis, adrenalin and other supportive measures there is marked improvement. A cannula is placed in the pericardial cavity and blood withdrawn. If after fifteen or twenty minutes there is no evidence of further bleeding, conservative therapy is continued. In the interim all preparations for operation are made. (3) Greatly increased pericardial pressure with no satisfactory response to conservative therapy. These are explored. (4) Free communication between pleura and pericardium with massive intrapleural hemorrhage. Immediate operation is performed and blood from the pericardial cavity is reinfused. He further points out that chance of recovery without exploration is slight when the wound has penetrated the heart.

Schiebel<sup>11</sup> apparently believes that all heart wounds should be explored since a healed wound may cause rupture or aneurysm when no surgical repair is performed.

Nelson,<sup>12</sup> in reporting a series of cases in 1943 from Charity Hospital, New Orleans, states that he believes patients with stab wounds of the heart should be explored. In certain cases the extent of injury is not immediately apparent and death may occur before surgery can be performed. He further states that patients who are brought out of shock and then relapse under conservative treatment are not apt to recover. Moreover, exploratory operation has little risk attached. He adds that the possibility of aneurysm formation and later pericardial adhesions cannot be ignored, and that aspiration of the pericardial sac is attended by the risk of puncture of a coronary vessel. From 1906 to 1943 there were twenty-seven cardiorrhaphies at Charity, and better results later in the series are attributed to more frequent exploration.

Blau<sup>13</sup> reports a series of twenty-seven penetrating wounds of the heart at the Detroit Receiving Hospital; twenty-one were operated on with a mortality of 23.8

per cent. Of the six remaining cases, three were observed and three were aspirated. In the whole series of twenty-seven cases there were six deaths, five in the operated group and one in the conservatively treated group, with a total mortality of 22.2 per cent. Blau also refers to a case reported by Vance in which death occurred eight days after the wound due to the wound edges being forced apart, with fatal tamponade resulting. He also refers to an article by Long in which Long states that the spontaneous closure of the parietal pericardium may result with a blood clot when the blood pressure is low, changing of relative openings of the myocardium and the pericardium as the hemopericardium increases, a small puncture wound of the pericardium over a large heart wound, or non-penetration of either pleural cavity.

Bigger<sup>9</sup> reported seventeen cases at the Medical College of Virginia Hospital. In twelve of these there were simple penetrating wounds of the heart cavities or lumina of the intrapericardial portions of the great vessels, and of these eight recovered and four died. A patient with a heart wound is put in Trendelenburg position, given morphine sulfate and atropine, and, if in collapse, 5 m. of adrenalin subcutaneously and 10 to 15 m. by vein. When there is no sign of tamponade, conservatism is practiced. In the past all patients with tamponade and signs of heart injury with massive or moderate hemothorax were operated on, but now operation is performed only when marked signs of tamponade persist or when the indications are clear. Otherwise treatment is conservative. He cites the case of a twenty-two year old patient with a bullet wound of the chest who, despite the fact that he had blood and air in the pericardium, had no tamponade. He was given supportive treatment and recovered. He cited another case of a patient who at operation had a clot attached to the anterior heart wall over one of the divided branches of the left descending coronary artery. This patient recovered without ligation of the artery.

Obviously, he adds, aspiration would have sufficed.

Strieder<sup>14</sup> reports the case of a twelve year old boy with a stab wound of the heart. Because of evidence of tamponade he was prepared for operation. But when a No. 16 gauge needle was introduced into the pericardial sac and 100 cc. of blood were obtained and reinfused into his vein, dramatic improvement and eventual complete recovery resulted without operation. The author adds, however, that the danger of aneurysm of the heart and coronary vessels is great so that non-operation in a case of this type is hazardous.

Griswold and Maguire<sup>1</sup> report forty-seven cases of diagnosed heart wounds treated at Louisville City Hospital in an eight-year period. Of these, seven were misdiagnosed and turned out to be pathological conditions of organs other than the heart. Thirteen died less than twenty minutes after admission to the hospital. Of the twenty-seven patients who lived longer than twenty minutes after admission, twenty-two were operated on with six deaths during or following the operation; five patients were treated conservatively with one death. Mortality for the twenty-seven cases was 25.9 per cent.

Elkin<sup>2</sup> reported thirty-eight cases operated upon for heart wounds, of whom twenty-two recovered without sequelae. He believes that operation should be carried out as soon as a heart wound is diagnosed. Three years later<sup>10</sup> he reported a series of twenty-three cases with eighteen recoveries. While in his first series infection played a large part in causing death, in the latter group this complication was not present due to more meticulous operative technic. He concurs with Bigger and Blalock that where there is no immediate urgency for operation and aspiration results in continued relief, conservatism may be practiced.

In the Military Surgical Manual on neurosurgery and thoracic surgery<sup>16</sup> it is stated that frequently these patients will respond to conservative treatment, as a

small heart wound may be sealed off during circulatory collapse. Pericardiocentesis is recommended when tamponade and hemothorax are not coexistent. When there is a reduction in venous pressure and arterial pressure is maintained, it may be assumed that bleeding has ceased and conservative treatment is to be continued.

Blalock and Ravitch<sup>17</sup> quote Felsenreich as saying that the treatment of penetrating ventricular wounds should be operative, while auricular wounds may be handled conservatively because of the likelihood of cessation of auricular bleeding. But other writers have stated that because of its lack of contractility and elasticity, wounds of the auricles are more apt to be followed by fatal consequences. They bring up the problem as to whether the end results may not be better if a more conservative policy is instituted, and believe that operation may be delayed if symptoms are due to tamponade and not to continued bleeding. They qualify this with saying that probably not more than two hours should elapse with continued tamponade and, if blood reaccumulates, pericardiectomy is indicated.

Glasser, Mersheimer and Shiner<sup>18</sup> quote Kosmin as saying that isolated pericardial injuries are much more rare than heart injury, occurring in the ratio of 1:10, conceivably because of heart activity, nature of the weapon and degree and direction of penetration. They quote Gunzling and Sarkisov as saying that the signs of isolated pericardial injury will be hemorrhage from the wound, dyspnea and increased cardiac dullness to percussion, but clear heart sounds with only temporary or insignificant signs of tamponade will also be present.

#### PATHOLOGICAL PHYSIOLOGY

The wound is most commonly caused by a knife or an ice pick, less commonly by a bullet; this is statistically borne out in all large series. In gunshot wounds, because of the destructive nature of the injury and because there is perforation of the heart,

rapid exsanguination and death occur so that these patients rarely come to operation. Schiebel<sup>11</sup> states that bleeding, when it occurs, is into the relatively inelastic pericardial sac, and the wound is frequently plugged by overlying muscle. The intrapericardial pressure rises and there is increasing pressure on the chambers of the heart as bleeding continues. As pressure in the right auricle rises, there is a decrease in cardiac intake and output, and cerebral anemia is rapidly followed by death.

It would seem reasonable to assume that where there is intrapericardial bleeding with increased atrial and venous pressure and decreased cardiac output, intravenous fluids would do little to alleviate the state of embarrassed circulation and peripheral shock. Though the trauma to the heart is severe, unless there has been extensive external hemorrhage or bleeding into the thorax, the presenting picture is one of collapse due to tamponade, diminished cardiac output and cerebral anemia. In fact, according to Elkin,<sup>15</sup> "a symptomless interval . . . during the time the pericardium fills with blood, is the most important point in the history." Typically the onset of symptoms dates back to a state of tamponade. Beck<sup>19</sup> believes that intravenous fluids cause a rise in arterial pressure if there is a fixed state of cardiac compression and some of the blood can escape from the pericardial cavity. Ward and Parker<sup>20</sup> believe that one must differentiate between symptoms due to shock of hemorrhage or tamponade. However, they conclude that intravenous infusions rarely do harm and may be lifesaving.

The work of Cooper, Stead and Warren, in 1944, and later papers published by them and Merrill and Brannon<sup>21-24</sup> have shown the beneficial effects of supportive intravenous therapy in these patients. They said that as the venous pressure goes up its effect is to overcome the block occasioned by the increasing auricular pressure. The amount of blood entering the veins is limited by the diminishing cardiac output, and increasing the blood volume

will increase the venous pressure and help combat tamponade. In their experiments on dogs they found that animals could survive 100 per cent more of increased intrapericardial pressure than before if given intravenous fluids. There was also an associated rise in arterial pressure. They concluded:<sup>21</sup> "In patients who survive until they reach the hospital the myocardial, and probably the pericardial rents are at least temporarily closed . . . it is possible that, in certain selected patients, raising the venous pressure by increasing the blood volume will restore the circulation to an adequate level without aspiration or operation."

In 1946 Brannon, Stead, Warren and Merrill<sup>23,24</sup> reported that when blood volume in humans was raised with intravenous fluids there was increased cardiac output and arterial pressure while the peripheral resistance dropped. They added, significantly, that patients who have suffered trauma may react with reflex vasodilation and present signs of circulatory collapse. These same men<sup>24</sup> studied four patients with stab wounds of the heart and found that the situation was different from chest wounds and hemorrhagic shock. They found the atrial pressure elevated, the arterial pulse paradoxical, cardiac output decreased and peripheral resistance up. When two of these were given intravenous albumin, there occurred a rise in atrial pressure, cardiac output and arterial pressure, improved oxygenation function of the blood stream and a diminished degree of paradoxical pulse as measured in the femoral artery. They state that where the circulation improves promptly without therapy, the main factor is probably one of reflex vasodilatation and not tamponade; but where failure persists until the intrapericardial pressure is lowered, it must be due to tamponade. Raising the venous pressure by intravenous fluids will not improve the circulation unless the pericardium will distend in diastole and permit the heart to receive more blood, or unless blood is being forced out of the sac.

That some part of the symptomatology complex of patients who suffer a penetrating wound of the pericardium and heart is due to reflex vasodilatation is a theory that seems attractive to us. Certainly, supportive treatment without aspiration has done nothing to remove whatever fluid is present to cause the tamponade, yet some of these patients will recover without residual signs of cardiac embarrassment. This has been so in three of our four cases presented.

#### CASE REPORTS

With the foregoing remarks and especially with the important experimental studies of the last mentioned investigators in mind, the following cases are presented:

CASE 1. E. J., a sixteen year old colored male, was admitted to the hospital May 14, 1946, with a history of having been stabbed in the left chest a short time before admission. Physical examination revealed a well nourished and well developed male in deep shock. The skin was cold, clammy and pallid; the pulse was rapid and weak; the blood pressure unobtainable and temperature was 95.6°F. There was a puncture wound in the fourth interspace 1 inch medial to the left nipple line. Heart sounds were distant, weak and rapid. Breath sounds were rapid and shallow, but examination of the lungs failed to reveal hyperresonance, dullness or flatness.

The patient was immediately given 500 cc. of plasma followed by 500 cc. of blood and then 1,000 cc. of 5 per cent glucose in saline. Within one hour he showed definite evidence of coming out of shock, began to talk coherently and the pulse became full and regular. He continued to show improvement and on the following day his only complaint was localized pain over the wound site. The temperature curve remained in the region of 101°F. for eight days and then returned to normal. He was discharged eleven days after admission without complaint.

X-rays taken within eight hours of admission and five days later are herein reproduced. The x-ray taken on May 14th indicated fluid in the left lower lung field. This was again noted on May 19th, when the heart shadow was grossly enlarged with C-T ratio of 12/23.5. Five

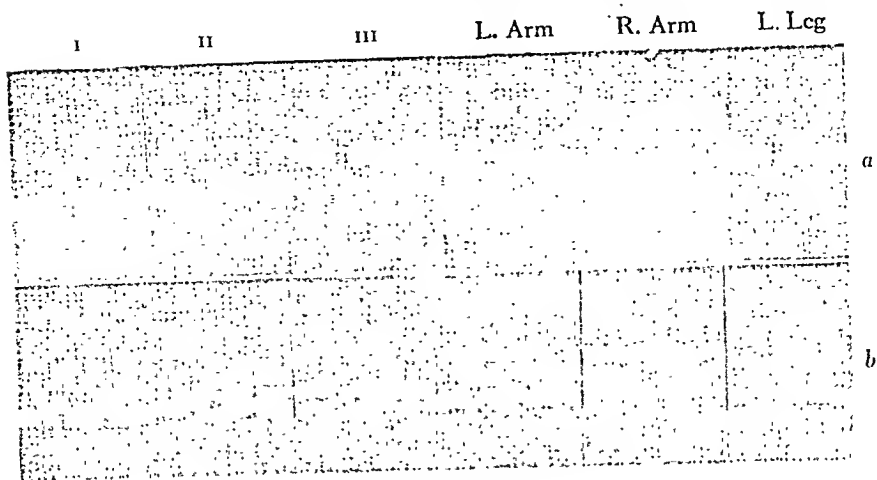


Fig. 1A

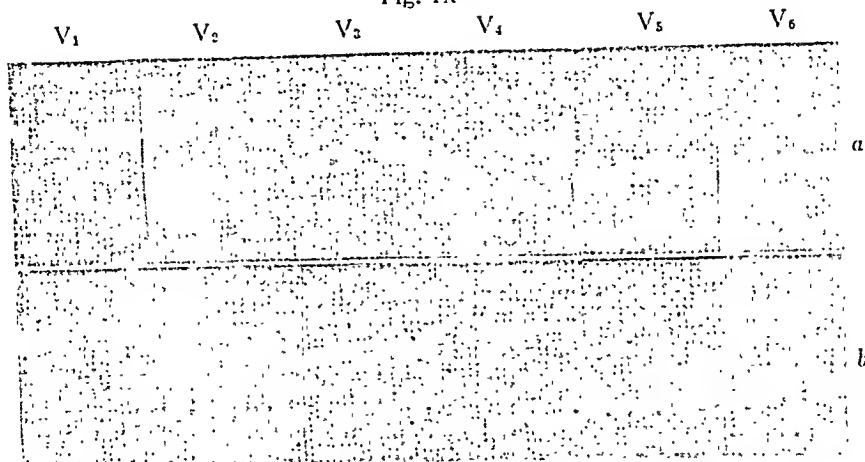


Fig. 1B



Fig. 1C

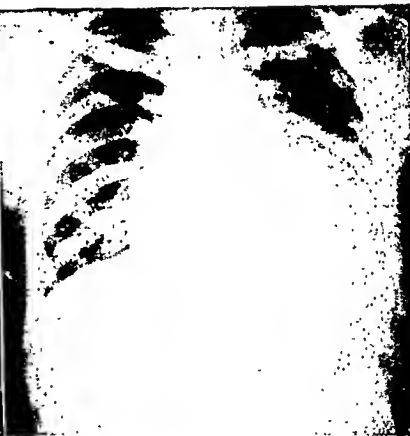


Fig. 1D

FIG. 1. Case 1, A and B, tracings taken seven days after the stab wound and five months later. The upper rows (a) reveal the following: The standard leads I and II show abnormal elevation of the RS-T segments. This can also be seen in the precordial leads V<sub>5</sub> and V<sub>6</sub>. This indicates that the stab wound had caused (directly or indirectly by means of a hemopericardium) myocardial injury. The lower tracings (b) are normal. c, May 14, 1946, bedside chest film showing diffuse clouding over the left lower lung field suggesting fluid. The heart does not appear unusual. d, on May 19, 1946, there was diffuse clouding of the left lower lung field with increased pulmonary markings, suggestive of fluid with underlying consolidation. The heart was now grossly enlarged, C/T ratio 13/23.5, which suggested pericardial effusion.



months later the heart and lungs were essentially normal. Electrocardiographic findings are recorded (Fig. 1) and show evidence of hemopericardium or myocardial injury. Tracings five months later are normal. Laboratory studies of the blood, urine and serology were all negative. Venous pressure, taken in September, was 100 mm. of water. The circulation time was normal.

Note that there was early x-ray evidence of fluid in the left lung field, and this was probably a communication between pleura and pericardium. Because the patient was comfortable, out of shock and without evidence of continued bleeding, exploration was not undertaken.

The location of the wound, clinical findings and the electrocardiogram provide proof of intrapericardial injury.

CASE II. A. D., a twenty-five year old colored male, was admitted to the ward on August 11, 1946, with a history of having been stabbed in the chest with a knife. On examination he was comatose, skin cold and clammy, pulse rapid and weak, respirations rapid and shallow, blood pressure 50/0. There was a 1 inch lacerating wound one inch from the sternal margin in the left fourth interspace, still oozing a small trickle of blood. Heart sounds were regular and distant at 140 per minute; examination of the lungs was negative.

The patient was given 500 cc. of plasma with 5 cc. of coramine intravenously and placed in an oxygen tent. This was followed with 500 cc. of whole blood and 1,000 cc. of 5 per cent glucose in saline. Within two hours he began to react favorably. He became coherent in his speech; his pulse became stronger and blood pressure rose to 74/36. Examination of the heart failed to reveal evidence of tamponade or cardiac shift. Ten hours following admission the blood pressure was 120/80 pulse rate 120 per minute; respiration 20 per minute. On the following day he had no complaint other than mild tenderness over the region of the wound. Fluoroscopy two days later showed diminished intensity of expansion of the right side of the heart, findings consistent with the presence of a small amount of fluid in the pericardium. His temperature rose to 102.8°F. twenty-four hours after admission but thereafter he ran an afebrile course. He was discharged asymptomatic fifteen days after admission.

On August 14th an upright film showed an enlargement of the heart to the right and to the

left, and on August 22nd a teleroentgenogram was suggestive of pericardial fluid. The electrocardiogram (Fig. 2) shows evidence of myocardial injury up to five weeks after the stab wound. On August 15th the venous pressure was 120 mm. of water; arm to tongue circulation time was 23 seconds; arm to lung circulation time was 10 seconds. Note that the circulation times are definitely prolonged. Other laboratory findings were negative.

Electrocardiograms, fluoroscopic examination, clinical findings and location of the wound support a diagnosis of penetrating heart injury in this patient.

CASE III. F. P., a fifty-one year old, colored male, was admitted to the ward with a transverse laceration in the fourth interspace on the left, approximately 2 inches from the sternal border. There was blood oozing from the wound. He was comatose; his skin was cold and clammy, blood pressure was 60/20, heart sounds were distant and rapid. The rest of the physical examination was essentially negative.

The patient was immediately placed on intravenous fluids which included 1,000 cc. of 5 per cent glucose in saline, 500 cc. of plasma and 500 cc. of whole blood, and he was placed in an oxygen tent. Within an hour he showed considerable improvement; his speech was coherent; his skin was warm and his blood pressure rising. Eight hours later he was quite comfortable.

On three occasions during his period of convalescence he complained of severe pain in the left chest which responded to mild sedation. Examination of the heart during these periods was negative. The patient was discharged from the hospital asymptomatic fourteen days after admission.

Fluoroscopy performed on August 14th showed normal contour of the heart on the left, with moderately diminished pulsation at the right lower border with obliteration of the normal cardiophrenic angle suggestive of a small amount of pericardial fluid. The electrocardiogram (Fig. 3) was normal five days after the stab wound. However, two weeks later there was evidence of myocardial injury and two months later the tracings were once more normal. On admission a portable chest plate was not remarkable. On August 12th there was reported to be a bulge in the wall of the left ventricle consistent with post-traumatic aneurysm and some diminution of illumination

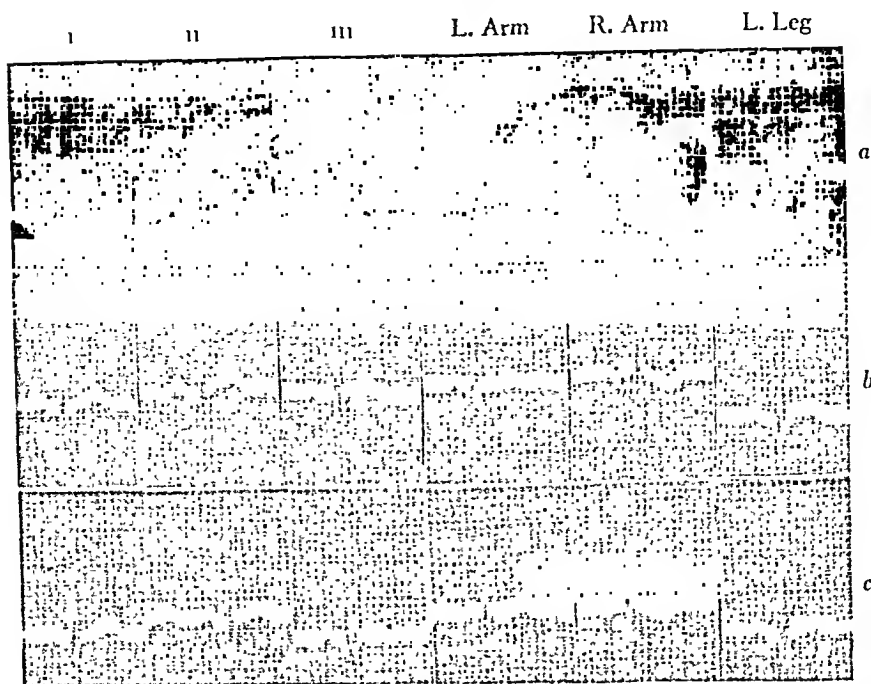


Fig. 2A

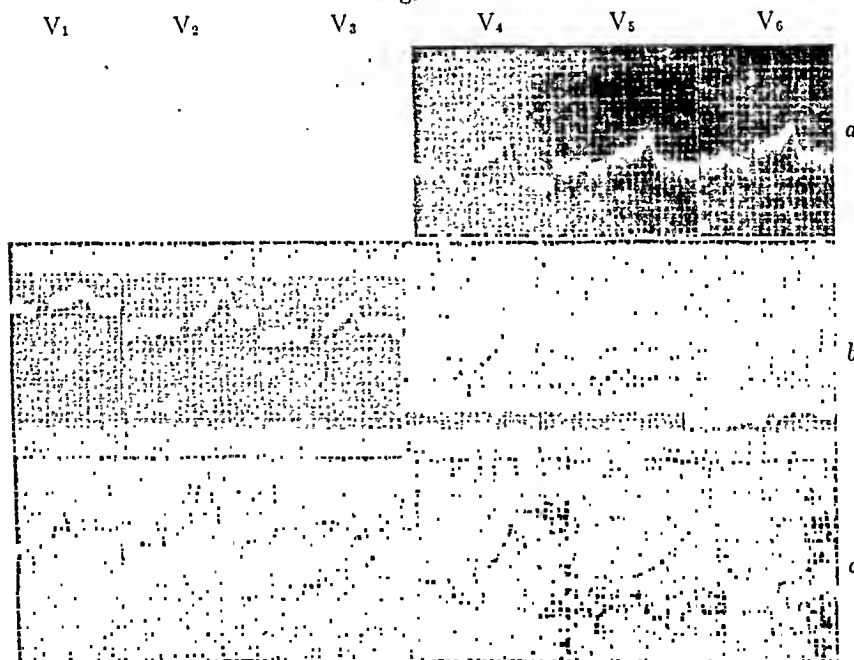


Fig. 2B

FIG. 2. Case 11, A and B, the upper rows (a) of tracings were taken two days after the stab wound. The middle rows (b) were taken twelve days after the stab wound, and the lower rows (c) were taken five weeks after the stab wound was inflicted. The upper rows show the following: only precordial leads  $V_4$  and  $V_6$  were taken because a dressing lay over the remainder of the chest. Marked and abnormal elevation of the RS-T segments of these leads were present. This indicated that the stab wound had resulted in myocardial injury. This was further confirmed by the elevated RS-T segments in leads I, II, L. Arm and L. Leg. The middle rows show the following: with the exception of lead  $V_6$ , the precordial leads are normal. The standard leads also appear normal but the L. Leg lead shows an abnormal elevation of the RS-T segment. The lower rows show the following: all the precordial leads are normal. The standard leads are also normal but signs of myocardial injury still are present in the L. Leg lead.

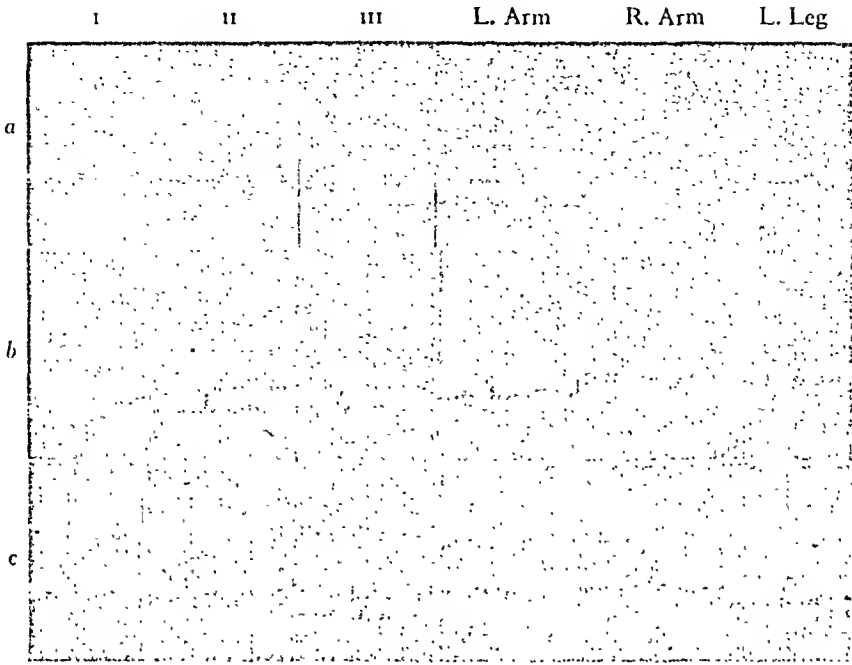


Fig. 3A

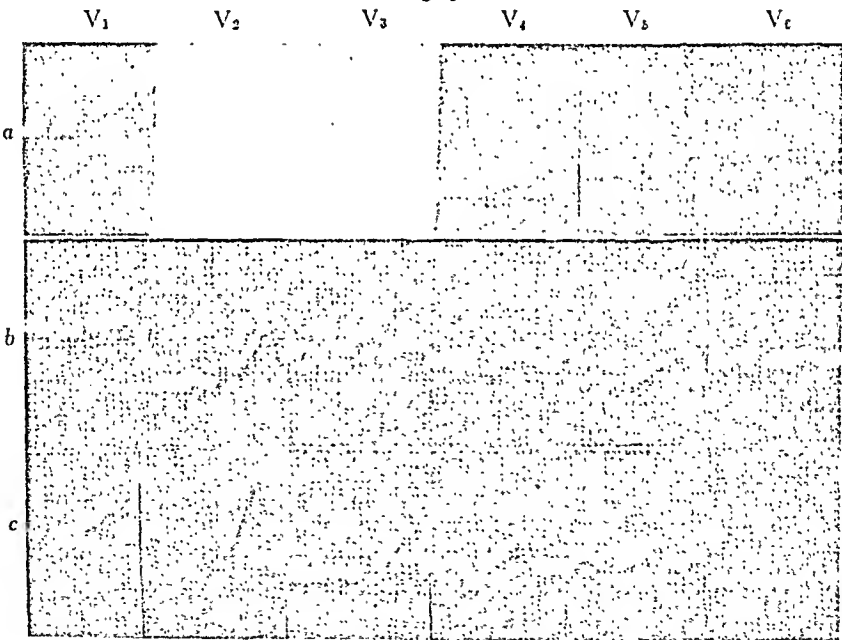


Fig. 3B



Fig. 3C

Fig. 3D

Fig. 2 For descriptive text.

in the left lower lung field. Calcification in the walls of the descending aorta would indicate that there might well be an antecedent history of arteriosclerotic heart disease in this patient. Venous pressure reading on the day after admission was 95 mm. of water, with arm to lung circulation time of 10 seconds and arm to tongue circulation time of 25 seconds. One month later the venous pressure was still normal; arm to lung time was 11 seconds and arm to tongue time was 20 seconds. These are considered retarded. Other than positive Kline and Wassermann tests, blood chemistries and hematologic study were normal. Figure 3D, taken two months later, shows the heart to be smaller.

Here again, the clinical findings and the electrocardiogram aided in making the diagnosis of stab wound of the heart.

CLASS IV. E. C., a twenty-one year old white female, was admitted to the ward with a history of having stabbed herself two hours before admission while drunk. Physical examination revealed a well developed and well nourished white female, conscious and oriented, with cold, pallid skin and blood pressure of 55/32. There was a lacerating wound in the third left interspace,  $\frac{3}{8}$  of an inch long, located  $\frac{1}{2}$  inch from the midline. Respirations were rapid and shallow and examination of the chest revealed hyperresonance to percussion note above the region of the fourth interspace with dullness below that level, while heart sounds were muffled and distant. There were no breath sounds to be heard over the entire left chest.

The patient was immediately started on 1,000 cc. of 5 per cent glucose in saline and then switched to plasma. A chest tap in the fifth interspace left mid-axillary line was unsuccessful, with only 12 cc. of blood withdrawn. Four hours after admission she appeared much

more comfortable, with the pulse stronger at 110 per minute; respirations smooth and regular at 30 per minute, and the skin warm and its color improved. Twelve hours after admission, however, it was noted that she was bleeding actively from her chest wound, and immediate exploration was deemed advisable. A laceration of the left auricular appendage of the heart was repaired at this time, 300 cc. of blood removed from the left pleural cavity and the patient was returned to the ward. Post-operatively she developed an empyema of the chest which responded to aspiration and supportive blood transfusions. The patient was discharged from the hospital thirty-six days after admission, relatively asymptomatic.

This patient was observed for a period of twelve hours before exploration was decided upon and the lacerated myocardium sutured. This may be accepted as further evidence that wounds of the auricles are less apt to be followed by the degree of rapid and massive bleeding characterizing lacerations of the ventricles and conservative therapy, while not advocated for this case, is apt to maintain the patient over a longer period of time. When there is communication between pleura and pericardium with evidence of continued bleeding, conservatism cannot be maintained for long and exploration becomes mandatory.

Though the essentials of treatment in the first three cases were supportive only, in the giving of oxygen, plasma, blood and isotonic fluids with stimulants when necessary, this is not presented as an argument for the non-operative handling of all wounds of the heart. When the hazards of operation, the chances of pericarditis with or without empyema, coronary occlusion

FIG. 3. Case III, A and B, the upper rows (a) of tracings were taken five days after the stab wound. The middle rows (b) were taken two weeks after the stab wound and the lower rows (c) of tracings were taken two months after the stabbing. The upper rows show the following: no abnormalities are present. Precordial leads  $V_2$  and  $V_3$  were not taken because this area was covered by the dressing over the stab wound. The middle rows show the following: standard RS-T segments and T waves indicating that myocardial injury is present. The lower rows are normal again. c, August 12, 1946, portable chest film shows some haziness in lower left lung field. A bulge in the left ventricular wall, consistent with post-traumatic aneurysm, was present. Calcification of the aortic arch and descending aorta were also noted. D, Two months later 6 foot film shows slight haziness in both lower lung fields.

with myocardial infarction, hemothorax and pneumothorax, pneumonia, embolism and atelectasis are considered, operation is not lightly undertaken and definite indications for it should be present. On the other hand, when it is remembered that non-operation may result in aneurysm of the heart or coronary vessels, or that at some time a clot may give way and sudden death occur, or that recurrent tamponade may cause death of cardiac failure and cerebral anemia, there should be no hesitancy in undertaking operation when the issue remains in doubt. Blau<sup>13</sup> quotes Dshanelidze as having proven that few cases have sequelae after operation. He collected 535 cases from the literature and in 96.5 per cent of 113 of these, who were followed for a number of years up to eighteen, there was no impairment of cardiac function. It would seem to us that the most satisfactory course, when conservative therapy has been decided upon, would be to have the operating room in readiness for immediate use should it become apparent that conservative measures have been to no avail.

#### CONCLUSIONS

1. In the presence of a stab wound, or other penetrating injury of the chest in the region of the heart, the electrocardiogram is useful in determining whether the pericardial cavity has been entered. Where there has been myocardial damage, the tracings will be of immediate diagnostic significance, and in pericardial damage the findings will be those of pericarditis and hemopericardium.

2. The use of unipolar extremity leads and multipolar precordial leads will help make the diagnosis of myocardial injury even when the standard leads are normal.

3. Signs of myocardial injury may remain in the unipolar extremity leads or multiple precordial leads even when the standard leads have returned to normal.

4. There are stab wounds of the heart that will respond to intravenous fluids, oxygen and stimulants. Among these are

included simple pericardial injuries and cases which in some manner the bleeding point has been occluded and there is little likelihood that bleeding into the pericardial sac will recur.

5. Intravenous fluids and aspiration of the distended, compressing pericardium may quickly relieve the embarrassed heart and circulation in injuries where bleeding is not apt to recur.

6. Preparation for operation, in the event that the patient has not responded favorably to such a regimen, should proceed concomitantly.

7. When a wound of the heart is accompanied by intrapleural injury and hemorrhage or evidence of considerable external bleeding, even in the presence of tamponade, the indications for prompt blood replacement are present. It is difficult, without aspiration, to distinguish between symptoms caused by blood loss and those of tamponade, and they may be coexistent.

8. Again, when external bleeding has not been excessive, when there is little or no hemorrhage into the pleura in the absence of signs of cardiac tamponade, the possibility remains that much of the symptomatology may be due to reflex vasodilatation, as pointed out by Warren et al. It is not unreasonable that injury to a vital organ may be followed by such a sequence of events, but the degree of shock should not be deep and the patient should be easily aroused. Such was not wholly the case in any of our patients.

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# NEW CONCEPT OF THE PATHOGENESIS OF URINARY LITHIASIS

IGNAZIO COLLICA, M.D.\*

Instructor of Surgical Pathology, University of Palermo

Palermo, Italy

AN article entitled "Incidence of Urinary Calculi in the American Negro" by Dodson and Clark† suggested to the author that a new concept on the pathogenesis of urinary lithiasis illustrated by him in 1919 with experimental work and confirmed in 1927 with two particular, ideal clinical cases would be of some interest to the profession. This article by Dodson and Clark contains statistics and opinions of many others. However, they all agree that the incidence of urolithiasis among negroes is very low as compared with that occurring in whites. After considering some of the common hypothetic factors of the many theories, which have failed, based only on the components of the urine or alterations of metabolism, all these authors conclude they are unable to explain the pathogenesis of this semi-immunity. The writer believes that with his new concept the fact can be reasonably explained.

In 1919 a number of experiments were performed on dogs for the purpose of studying the behavior of normal urine or, if necessary, of urine artificially modified or infected, in contact with small pieces of foreign substances introduced into the kidneys. These foreign bodies were of such a size that they could not be passed through the ureters. Retained in the kidneys, these substances functioned as natural nuclei on which calculi could be formed.

In all seven nuclei introduced into the kidneys (Fig. 1), the first by pyelotomy and the others by nephrotomy and kept there for an average period of three months, deposits of salts were found and of all the salts contained in the urine, independently

of their concentration (Table 1) and in the cases in which infection or semi-obstruction to the flow of the urine occurred, real calculus formations were obtained. (Fig. 2.)

This condition occurs in man when an occasional anatomic anomaly in any part

TABLE I  
CHEMICAL AND MICROSCOPICAL FINDINGS IN THE SEVEN INCIDENCES OF CALCULOUS FORMATIONS

1. Sodium urate, lime phosphate, ammonium magnesium phosphate, few crystals of calcium oxalate, certain amount of organic substance, positive bacteriologic findings
2. Neutral ammonium magnesium phosphate in thin "bacilli-shaped" crystals, calcium sulfate, crystallized in form of prismatic needles forming "rosettes," negative bacteriologic findings
3. Ammonium magnesium phosphate, ammonium urate, some organic substance, positive bacteriologic findings
4. Good amount of amorphous urates, lime phosphate, neutral magnesium phosphate in thin bacilli-shaped crystals, negative bacteriologic findings
5. Lime phosphate, uric acid crystals of losange shape, great amount of amorphous substance, few urate, germs of bacillary shape
6. Many crystals of lime phosphate, bicaleic phosphate wedge-shaped, united by the apices, ammonium urate, positive bacteriologic findings
7. Ammonium phosphate, ammonium urate, few irregular crystals of ammonium magnesium phosphate, great amount of amorphous substance, positive bacteriologic findings

of the urinary tract retains such nuclei as blood clots, groups of crystals, bits of gravel, collections of pus, etc. We are thus reminded of the great specific value that must be given this anatomic factor when considering the genesis of urinary lithiasis. The production of urinary calculi will not occur if this anomaly in the urinary tract does not exist, no matter what the composition of the urine or the alterations of metabolism.

Two particular clinical cases that were reported by the author at the meeting of

† J. A. M. A., 132: 1063-1066, 1946.

\* Formerly Visiting Surgeon of Columbus Hospital, New York, N. Y.

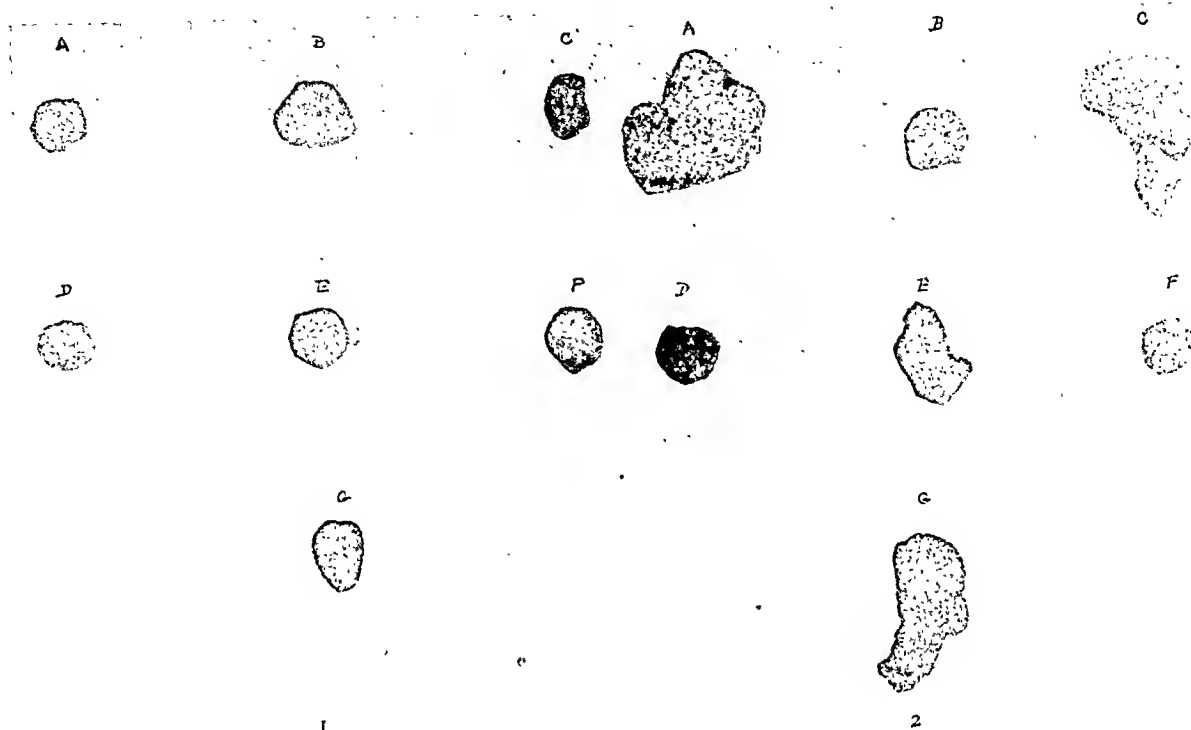


FIG. 1. Pieces of wood, stone and rubber introduced in the pelvis of the kidneys of dogs.

FIG. 2. Calculous formations on the same bodies after three months of being lodged in the pelvis of the kidneys.

the Italian Society of Surgery in October, 1927, in Parma, illustrate this assertion very clearly. These two cases presented factors that are always present even in micro-dimensions in all cases of urolithiasis.

A man came under the author's observation with severe urinary symptoms seventeen months after prostatectomy was performed by another surgeon. A large stone was found in the bladder the size and shape of a small egg. (Fig. 3.) This calculus had formed on a piece of necrotic tissue accidentally left behind in the bladder at the first operation.

Another man presented himself to be operated upon for bilateral inguinal hernias. He could no longer bear the severe, insufferable urinary symptoms that started in mild form about ten years previously and which had become progressively worse. Since these are not the symptoms attributable to hernias, the possible presence of a pathologic condition of the prostate was considered. However, upon rectal examination a large, elongated, hard tumor was found prominent in the rectum behind a normal prostate and upon catheterization it was ascertained to be a stone.

At operation a large calculus the size and shape of a bar of common hand soap (Fig. 4A) was removed with great difficulty. One-half of this calculus protruded into the bladder and the other half, imbedded

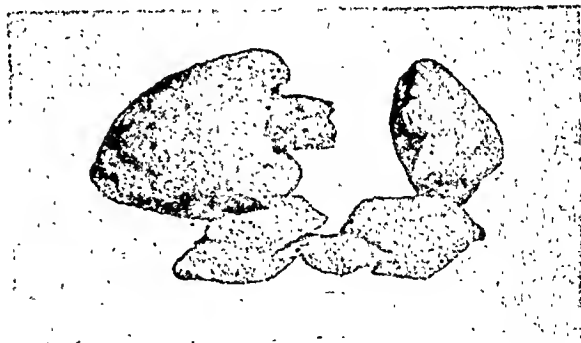


FIG. 3. Phosphatic calculus formed on a piece of prostatic tissue dislodged in the bladder.

in a diverticulum of the fundus of the bladder, dipped toward the rectum. The stone was tightly fixed by a strong ring of hypertrophied bladder tissue which left a constriction (Fig. 4B) well outlined on the middle of the calculus. This man had suffered twenty years before with severe renal colic with bloody urine but without emission of any concretion. The nucleus very likely fell from the kidney, entered the



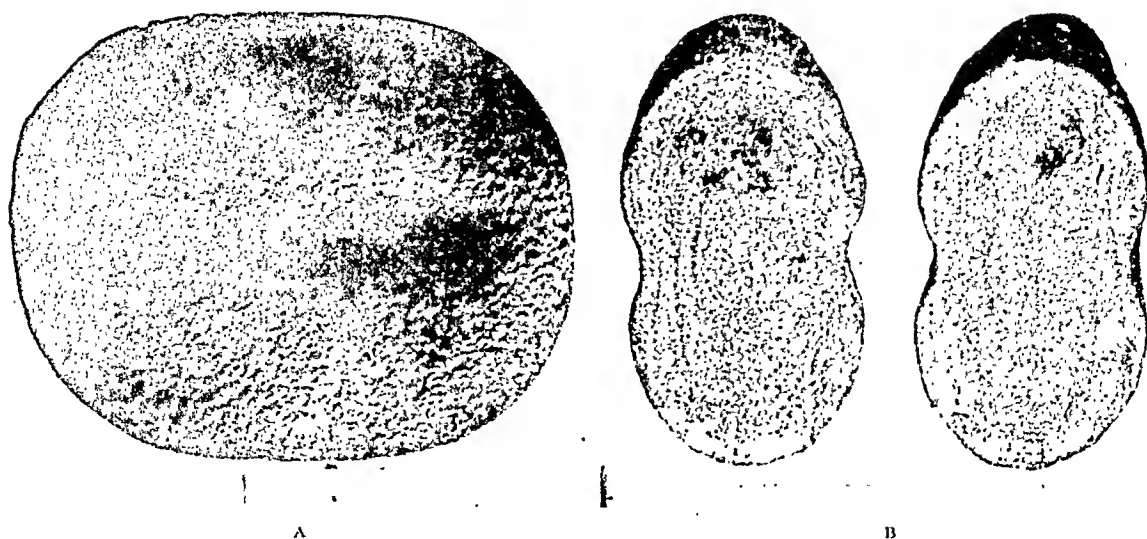


FIG. 44 A, calculus with medial constriction produced by a ring of hypertrophied bladder tissue. B, same calculus transversally sectioned.

existing diverticulum of the bladder and remained there silent for over ten years.

In the first case if the piece of prostate had not been left in the bladder or if the substance was so small as to pass through the urethra, or in the second case if the diverticulum of the bladder did not exist and did not retain the nucleus, which had migrated twenty years before from the kidney, these two men very likely would never have suffered with calculi even though they possessed the ability to produce stones. No better proof exists, than that an anatomic anomaly in the urinary tract and an occasional nucleus are the real, true and only pathogenetic factors in urinary lithiasis.

All the other theories: of acid and alkaline fermentation (Scherer), of lithogen catarrh (Meckel), of supersaturation (Berzelius), of superposition (Chopart, Heller, Robin), microbic theory (Naunyn and Galippe), of colloids (Rainer, Harting, Ord, Shade), of cementing organic substance (Carter, Fourcroy, Moritz, Aschoff, Kleinschmidt) and the hystonecrotic theory (Ebstein, Pousson, Charles) are factors that involve the *formation* of calculi. They constitute the biochemical and biophysical, local and general underlying conditions favorable to the formation of calculi. The intrinsic essence of a calculus is simply

influenced by the different characteristics of these conditions, namely, speed of formation, appearance, consistency and different structures, but a calculus will never be formed if the necessary anatomic condition capable of retaining that occasional nucleus does not exist in the urinary tract.

Based on this assumption many theories could be easily clarified. For example, why are calculi not formed in all septic cases and why not in all diathetic conditions with the urine supersaturated with different salts? The answer to this question is: Because the specific, absolutely necessary, pathogenetic factor, namely, the anatomic anomaly, is missing. At the same time other factors, considered until now only empirically in the etiology of urolithiasis, could be interpreted scientifically and objectively. The theories of inheritance, of different susceptibilities in different races and in different regions could all be explained. In the case of the negro whom we know possesses a well developed constitution, perfect dentition, freedom from dental caries, densely calcified bony structure, etc., it is not unreasonable to assume that his urinary organs also are more perfectly developed, and the rarity of existing anomalies explains the low percentage of urolithiasis.

# TREATMENT OF INFECTIONS OF THE EXTREMITIES

## CLINICAL RESULTS OBTAINED WITH A COMBINATION OF ICE, TOURNIQUET AND INTRA-ARTERIAL PENICILLIN

RICHARD A. GILBERT, M.D. AND RICHARD A. CALL, M.D.

*Baltimore, Maryland*

*Salt Lake City, Utah*

A GROUP of workers at the Metropolitan Hospital, New York City, reported rapid improvement of infection in an extremity which had been treated with intra-arterial penicillin. The method of treatment they advocated required that a tourniquet be placed about the thigh of an infected lower extremity, shutting off the venous return from the leg but not tight enough to constrict the femoral artery. Penicillin was then injected into the femoral artery and the tourniquet allowed to remain *in situ* for fifteen minutes. This method was said to cause an extravasation of penicillin into the tissues of the leg and maintain a high concentration of penicillin in the tissues for the length of time the tourniquet was kept in place. These workers believed that the dictating factor responsible for the therapeutic success of this procedure was due to the increased concentration of penicillin extravasated into the tissues and to the prolonged time that the penicillin was maintained in the tissues.

The longer the tourniquet could be kept in place, the longer the penicillin could be trapped at the site of infection. If an extremity were to be packed in ice, no damage would result if the blood stream was cut off for several hours.

Gilbert and Call<sup>2</sup> have reported excellent results in treating wound infection by local infiltration of the wound with penicillin and maintenance of a high tissue level of the drug by keeping the site of the wound chilled with ice. In view of our success with the combination of ice and penicillin infiltration we decided to treat a series of wound infections of the extremities with ice, tourniquet and intra-arterial penicillin.

### METHOD

Thirty cases of wound infection of the lower extremities were divided into two groups containing fifteen patients in each, designated group 1 and 2. Each group contained five patients with marked toxic symptoms such as hyperpyrexia, marked redness and tenderness about the wound and regional lymph node tenderness; five patients showed a moderate febrile response and a moderate amount of tenderness about the wound; and five patients showed only a mild systemic and local reaction toward the infection. The wounds in each group compared fairly well in regard to length, depth and irregularity of cut surface with the wounds of patients in each of the other groups. The infecting organisms were streptococci or staphylococci. None of the infections were produced by gram-negative bacilli.

### PROCEDURE AND RESULTS

*Group 1.* The fifteen patients in this group received 50,000 units of penicillin intragluteally every three hours until symptoms of infection had remained absent for twenty-four hours. The total dosage was 500,000 to 2.5 million units. In the five severe cases of this group infection disappeared at the end of the sixth day in two patients, at the end of the fourth day in two and at the end of the third day in one.

In the five cases of moderately severe infections one patient was asymptomatic by the end of the fourth day, four by the end of the third day and one by the end of the second day.

In the five mild cases three patients were asymptomatic by the end of the first day.

and twelve hours after initiation of treatment two were asymptomatic. The average hospitalization was eleven days.

*Group 2.* In the fifteen cases in this group eight ice bags were placed about the leg with an infected wound. The leg was chilled from the upper one-third of the thigh down to the toes. One hour later a tourniquet was placed about the chilled thigh, tight enough to cut off all venous return from the leg but loose enough to allow the femoral artery to remain patent. The patency of the femoral artery was assured if the pulsations of the dorsalis pedis could be felt.

The area over the femoral vein was prepared with tincture of merthiolate, and 500,000 units of penicillin dissolved in 20 cc. of sterile water were injected directly into the femoral artery. The tourniquet was left in place for three hours and the ice was not removed until twelve hours after the intra-arterial injection of penicillin.

In the five severe cases of this group infection disappeared at the end of the ninth day in three patients and at the end of the fourth day in two.

In the five cases of moderately severe infection one patient was asymptomatic by the end of the first day and four by the end of the fourth day.

In the five mild cases one patient was asymptomatic by the end of the second day, one by the end of the first day and three were asymptomatic twelve hours after initiation of treatment. The average hospitalization was eleven days.

#### COMMENT

Shutting off the blood to a chilled extremity for several hours seems to be without danger. We have left a tourniquet on the thigh and have shut off the venous return of a chilled leg for as long as seventeen hours without damage to the extremity. The tourniquet which constricts the venous return but allows the femoral

artery to remain patent creates a high venous pressure in the leg. An edema results and, of course, carries penicillin (which has previously been injected into the femoral artery) out into the tissues. However, this edema probably lowers the tissue resistance to infection for it has long been recognized that an infection in edematous tissue is most difficult to control. The administration of penicillin in the usual interrupted intragluteal method is far less troublesome and is as effective or probably more effective in combating wound infections of the extremities than the more cumbersome use of ice, tourniquet and intra-arterial penicillin.

Gilbert, Call and Roose<sup>3</sup> demonstrated that penicillin could be kept concentrated at the site of an infected wound for at least twenty-four hours after the area surrounding a chilled wound was locally infiltrated with penicillin. This appears to be a more effective and less cumbersome method of keeping penicillin localized than by the use of a tourniquet.

#### SUMMARY AND CONCLUSIONS

The results in the treatment of fifteen patients with wound infection by means of ice, tourniquet and intra-arterial penicillin were compared with the results obtained by treating fifteen patients with similar wound infection by means of the usual interrupted intragluteal penicillin therapy.

There is no therapeutic advantage in the use of a combination of ice, tourniquet and intra-arterial penicillin over the results obtained by the use of interrupted intragluteal penicillin as outlined in this series of cases presented.

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# Case Reports

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## BENIGN ULCER OF THE GREATER CURVATURE OF THE STOMACH\*

G. R. KENNEDY, M.D. AND ERWIN BECK, M.D.

*Aspinwall, Pennsylvania*

THE location of an ulcerative lesion in the stomach is one of the most reliable guides in deciding upon the probability of its being benign or malignant. The hazards of conservative treatment in this regard have been fairly well determined. This is especially true in lesions of the greater curvature which are nearly always malignant. The other common criteria such as the age of the patient, duration of symptoms, size of the lesion, gastric acidity and response to ulcer therapy are notoriously undependable in making the decision in the individual case as to the necessity for operation. In the experience of the Massachusetts General Hospital<sup>1</sup> lesions of the greater curvature are malignant in 100 per cent, of the prepyloric area in 65 per cent, of the anterior and posterior walls in 20 per cent, of the pylorus in 10 per cent and of the lesser curvature in 10 per cent. Similar figures are reported from the Mayo Clinic.<sup>5</sup> Wiley<sup>21</sup> in his review on gastric ulcer has found prepyloric ulcer variously reported as 75 to 83 per cent malignant.

The rarity of benign ulcers of the greater curvature is attested to in general terms by Kirklin,<sup>9</sup> Palmer,<sup>12</sup> Templeton<sup>20</sup> and Bockus.<sup>4</sup> In 1931 Pancoast, discussing a paper by Sproul,<sup>17</sup> said he had encountered but one case; L. G. Cole, discussing the same paper, admitted being wrong both times he had made such a diagnosis. Lahey<sup>10</sup> has never seen a benign ulceration of the greater curvature.

Sproul's communications with leading roentgenologists in 1931<sup>17</sup> showed not one who had a histologically confirmed diagnosis of benign greater curvature ulcer. He is critical of the many case reports, such as Blaine's three cases<sup>2</sup> which had no histologic confirmation, and could find only ten histologically proved cases in the literature up to 1928. Holmes and Hampton<sup>8</sup> cite Orator's study of 330 cases of gastric ulcer from Eiselberg's clinic without a single benign ulcer of the greater curvature.

Rivers and Dry<sup>16</sup> found records of only four cases in the files of the Mayo Clinic up to 1935; their patient was a girl of twenty-one whose film showed a large ulcerating greater curvature lesion deemed malignant preoperatively. At operation a benign 2 cm. crater was found 5 cm. above the pylorus, with no histologic evidence of malignancy.

Matthews<sup>11</sup> reiterated the need for microscopic study before a diagnosis of benign greater curvature ulcer is made. His first case was a woman of fifty-seven with symptoms of thirty-five years' duration and no free hydrochloric acid. His second case was a man of fifty-seven with symptoms of one year's duration, somewhat high free hydrochloric acid of 52 units and a palpable mass. In both cases an apparently malignant greater curvature filling defect by roentgenogram proved benign at operation, the mass in the second being inflammatory due to chronic perforation.

\* From the Roentgenologic Service, United States Veterans Administration Hospital, Aspinwall, Pa. Published with permission of the Chief Medical Director, Department of Medicine and Surgery, Veterans Administration, who assumes no responsibility for the opinions expressed or conclusions drawn by the author.

Williams<sup>22</sup> reported two cases of benign greater curvature ulcer found at autopsy, the only examples in the hospital records at San Francisco Hospital up to 1941. Both patients were admitted in a moribund state and died shortly after. The lesion in the first case was prepyloric with a large six-hour retention and no free hydrochloric acid; in the second case it was a large ulcer 6 cm. from the pylorus.

Clagett<sup>6</sup> reviewed all cases of chronic gastric ulcer treated surgically at the Mayo Clinic from 1933 to 1937, 272 in all, 220 men and 52 women: 182 (67 per cent) were on the lesser curvature at or above the angle, 43 (16 per cent) were on the lesser curvature between the angle and pylorus, 41 (15 per cent) were on the posterior wall near the angle, 2 were on the anterior wall and 4 (1.4 per cent) were on the greater curvature.

Allen and Welch<sup>1</sup> studied the records of all patients with a diagnosis of gastric ulcer treated at the Massachusetts General Hospital for the ten-year period 1930 to 1940. Of the total of 255 benign ulcers analyzed none were on the greater curvature. Of the patients whose clinical diagnosis was gastric ulcer 14 per cent proved to have carcinoma. All lesions of the greater curvature were malignant.

A study of over 200 cases of large gastric ulcers seen at the Cook County Hospital in the ten years prior to 1943<sup>18</sup> revealed over 90 per cent in the pars media of the stomach but none on the greater curvature. At the Lahey Clinic<sup>10</sup> 8,516 cases of peptic ulcer have been treated with bed management; of these 571 were gastric, a ratio of duodenal to gastric ulcer of about 14 to 1. None were located on the greater curvature and Lahey concludes that "while these have been reported, anything other than radical surgery for the patient with an ulcer on the greater curvature is futile."

The case reported by Preiss<sup>15</sup> from England in 1944 was a thirty-four year old man with symptoms of eighteen years' duration. Roentgenograms demonstrated an ulcerative lesion of the greater curvature

with folds converging toward the niche. Operation, performed because of failure to heal and the danger of malignancy, disclosed a chronic gastric ulcer. Blum's case<sup>3</sup> reported in 1944 was the first at the United States Veterans Hospital, New York City, among several thousand peptic ulcers of which several hundred came to operation. His patient, a forty-nine year old man who had symptoms for twelve years, was referred to the hospital with a diagnosis of gastric carcinoma after severe hemorrhage. His free hydrochloric acid was 57 and roentgenograms showed a niche 2.5 cm. in diameter on the greater curvature with prominent ruga converging toward it; at operation the chronically perforating gastric ulcer adherent to the serosa of the transverse colon was found 6 cm. from the pylorus on the greater curvature. Even with the lesion in his hand, the surgeon was uncertain whether it was benign or malignant.

Necropsy studies have not contributed much because of their apparent discrepancy with clinical studies, especially in the ratio of duodenal to gastric ulcer, but also in the abnormal incidence of clinical rarities. Among 7,700 consecutive necropsy records at Bellevue Hospital<sup>10</sup> 1904 to 1922, there were 120 cases of gastric ulcer of which nineteen were on the greater curvature and only forty-one on the lesser curvature. The applicability of such figures, when compared with reliable clinical studies, may be seriously questioned because of the known occurrence of gastrointestinal ulceration in agonal states.

Portis and Jaffe<sup>14</sup> found 196 gastric and 146 duodenal ulcers in 9,171 consecutive autopsies at Cook County Hospital. Gastric ulcer was the essential lesion in fifty-five, duodenal ulcer in sixty-three. This is in marked contrast with clinical figures of about fourteen duodenal to one gastric ulcer at the Lahey Clinic and about ten to one at the Mayo Clinic. Of the 196 gastric ulcers 116 (59 per cent) were within 6 cm. of the pylorus: ninety-seven on the lesser curvature, ten on the anterior wall, six on

the posterior wall and three on the greater curvature; forty-nine or 25 per cent were more than 6 cm. from the pylorus, one being on the greater curvature. It is obvious that necropsy and clinical studies are not directly comparable when, in addition to the discrepancies first noted, the clinical incidence of almost 90 per cent of gastric ulcers in the pars media of the stomach is recalled.

The case to be reported is the first case of a benign greater curvature ulceration to be found in the records of the United States Veterans Hospital at Aspinwall, Pa.

#### CASE REPORT

G. R., a forty-six year old white hospital attendant, was admitted to this hospital February 15, 1946, complaining of abdominal pain, nausea, vomiting, weight loss, weakness and malaise. For about three weeks before admission he had mild dull pain over the left lower ribs and in the epigastrium, with the onset of severe epigastric pain unrelated to food, nausea and frequent vomiting two days prior to admission. He claimed to have lost 25 pounds the month before admission. Digestive complaints had been rare prior to the present episode. Upon examination he appeared to be weak and pale; he was edentulous. Blood pressure was 148/80, heart and lungs were essentially negative. The abdomen was soft and flat; there was some epigastric tenderness but no masses were palpable. Upon admission it was found that the Wassermann and Kahn tests were negative; urine negative; hemoglobin, 87 per cent (15 Gm.); red blood cells, 4.6 millions and white blood cells, 9,950.

Because of the repeated vomiting for the first three days, the patient had a liquid tray with supplementary intravenous infusions of glucose and normal saline. A No. 1 Sippy diet was begun on the third day. Vomiting ceased two days after admission, the pain and tenderness generally disappeared and he began to eat, feel well in general and put on a little weight.

Roentgen examination of the stomach March 1, 1946, (Fig. 1) showed a crater-like protrusion on the greater curvature at the junction of the middle and distal thirds. At six hours the stomach was empty except for a small



FIG. 1. Roentgenogram of March 1, 1946, showing the crater on the greater curvature of the stomach at the junction of the middle and distal thirds.

amount of barium retained in this crater. Gastroscopy on March 11th visualized no lesion nor was one demonstrated upon repetition of the roentgen studies on March 25th. On March 9th his blood count and sedimentation rates were normal. Fasting gastric residue was 11 cc., free hydrochloric acid 17 with a total of 32. He continued to feel well and was eager to return to work. He was discharged April 6th with a recommendation to return in six weeks for reexamination.

Roentgen studies on May 31, 1946, reported a suspicious lesion on the greater curvature just proximal to the prepyloric area. He was readmitted June 11th complaining of some distress deep in the abdomen present since his last roentgen examination. It occurred one hour after meals, on an empty stomach or at night and was relieved by milk. There was no vomiting or evidence of bleeding. Physical examination was essentially negative, the abdomen being flat, soft and non-tender; blood and urine studies were normal. Gastroduodenal roentgen study on June 13, 1946, (two days after readmission) showed a prominent rugal pattern, ragged and irregular in appearance,



FIG. 2. A low power view through a typical area showing normal mucosa at the margins of the ulcer, dense fibrosis extending to the serosa and heavy diffuse and perivascular infiltration of lymphocytes. No evidence of malignancy.

particularly in the lower portion and along the greater curvature where there was a persistent projection with rugal folds running into it. This area of the greater curvature was the same in position and appearance as the original crater visualized; it was somewhat tender. There was slight gastric retention at four hours. The roentgenologic diagnosis was ulcer of the greater curvature of the stomach, probably malignant.

This diagnosis was concurred by the surgical consultant and radical partial gastrectomy was performed July 2, 1946, with removal of the omentum and several small soft glands from the anterior surface of the head of the pancreas. The indurated area on the greater curvature was about 7 cm. proximal to the pyloric ring. No evidence of metastatic malignancy was seen in the abdomen.

The patient made a fairly uneventful recovery. Reexamination on July 23rd showed a well functioning anastomosis, with no evidence of recurrent ulceration. His hospital stay was somewhat prolonged by his emotional instability which had prevented preoperative gastroscopy and gastric analysis, but he was finally discharged September 4, 1946, in good condition.

Pathologic examination of the resected specimen (Fig. 2) revealed two ulcers astride the greater curvature 5.5 cm. from the pyloric end, 3.2 and 0.5 cm. in greater diameter, respectively. The margins were sharp, the base firm and fibrous. In the ulcerated areas the

mucosa and submucosa were replaced by chronic granulation tissue; there were some areas of fibrosis and some areas densely infiltrated with chronic inflammatory cells (mainly lymphoid). The stomach wall throughout was thickened, with fibrosis of the muscular and serosal layers and infiltration of the mucosal and submucosal layers with round cells, macrophages and eosinophiles. In one area the gastric mucosa was covered by a thin acute inflammatory exudate consisting largely of polymorphonuclears. All layers of the stomach were heavily infiltrated with inflammatory cells. Perigastric and omental lymph nodes showed moderate follicular hyperplasia.

Pathologic diagnosis: (1) chronic gastric ulcer; (2) acute and chronic gastritis.

#### COMMENT

In this case the age of the patient, lack of chronicity of symptoms, low acidity, recurrence and particularly the location of the lesion all suggested malignancy; the severity of the pain, the strong psychogenic factors present and the striking response to medical treatment all favored a diagnosis of benign peptic ulcer. However, the extreme infrequency with which ulcerative lesions of the greater curvature prove to be benign makes operation mandatory, regardless of the patient's suitability as an operative risk.

Why the greater curvature of the stomach is so immune to peptic ulceration has not been adequately explained. Even malignant lesions involve the greater curvature less frequently than other parts of the stomach. The factors of less mechanical irritation and trauma and of better blood supply to the greater curvature than to the lesser may play a part<sup>11</sup> but this remains conjecture.

#### SUMMARY

1. The more recent literature on the incidence of benign ulcer of the greater curvature is reviewed showing its marked infrequency even in large clinical experience.

2. A case of benign ulcer of the greater curvature of the stomach is reported which

was proved by operation and careful pathologic study.

3. Benign ulceration of the greater curvature of the stomach is a diagnosis to be made only after histologic examination of the resected lesion.

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# METASTASIZING CARCINOID TUMOR OF THE APPENDIX AND CECUM\*

VLADIMIR ALTMAN, M.D. AND NORMAN MANN, M.D.

*New York, New York*

CARCINOID tumor of the appendix has been frequently reported in the literature. Tumors of this type occurring elsewhere in the gastrointestinal tract are infrequent. Lubarsch in 1888 was the first to describe a carcinoid tumor of the ileum. He reported two cases of multiple nodules in the ileum and noted the striking histologic and clinical differences between these tumors and the adenocarcinomas found elsewhere. However, despite their being atypical, he designated his cases as "primary carcinomata" of the ileum. In 1890 Ransom reported other structural details of tumors which are now generally recognized to have been carcinoid tumors. The origin of the tumor has been the subject of much discussion. They have been thought of as endotheliomas by some, by others as related to basal cell carcinomas. In 1907 Oberndorfer introduced the name carcinoid to emphasize their malignant appearance in contrast to what he considered the harmless clinical course.

In 1914 Gosset and Masson<sup>1</sup> noted that the argentaffin or Kultschitzky cells, which are found diffusely distributed throughout the mucosa of the gastrointestinal tract, the pancreas and the gallbladder, reduced an ammoniacal solution of silver salts. Silver-staining granules in the cytoplasm were demonstrated. When the carcinoid cells were treated by the same silver impregnation methods, the same granules were observed. It is now generally accepted that the carcinoid tumor arises from these Kultschitzky cells. The term argentaffinoma has been applied because of the silver-staining properties. This theory would well explain the fact that carcinoids have been found in various parts

of the gastrointestinal tract and in the gallbladder. However, it would be difficult to understand the appearance of primary carcinoids in the mesentery. One theory that has been formulated which would clarify this problem has been that the argentaffin cells are derived from the neuroectoderm, migrate first to the celiac ganglions and then along the courses of nerves to the intestinal wall and finally reach the mucosa. The opinion is advanced that some of these cells may remain behind in the mesentery and later produce carcinoid tumors.

## OCURRENCE AND PATHOLOGY

The appendix is known to be the most common site for the tumor with the small intestine being second in frequency. The large bowel, the remainder of the gastrointestinal tract and the gallbladder follow in somewhat that order. No special predilection for either sex is noted. Generally speaking, carcinoids are found in approximately 0.3 per cent of all routine surgically removed appendices and constitute 90 per cent of all tumors of the appendix. Eighty-five per cent of all carcinoids occur in the ileocecal region including the ileum and the appendix. To date, according to Reitz<sup>2</sup> 400 malignant intestinal carcinoids have been reported. Although Forbus<sup>3</sup> originally considered them to be benign, Wyatt<sup>4</sup> stated that 22.5 per cent of recorded carcinoids of the small intestine were malignant. The per cent of malignancy in carcinoids in unusual locations (outside the appendix and small intestine) is thought to be 25. As for malignancy in the appendiceal carcinoids this is extremely rare.

\* From the Department of Pathology, Goldwater Memorial Hospital, Welfare Island, N. Y.

Raiford<sup>5</sup> in 1933 reported the incidence of carcinoids in the pathology laboratory of the Johns Hopkins Hospital. He found twenty-nine cases among 62,000 specimens which included autopsy and surgical material. There was one carcinoid of the stomach, nine of the small intestine, one involving the appendix and two in the large bowel. In two cases the tumor had multiple origin. Porter and Whelan<sup>6</sup> in 1939 reported an incidence of appendiceal carcinoid of 0.2 to 0.5 per cent of all surgically removed appendices. Of 26,384 appendices removed at the Boston City Hospital from 1910 to 1937 seventy-two contained argentaffinomas. During the same period two carcinoids of the stomach, one of the gallbladder and eight of the small bowel were found. None was found in the large bowel. Only three of the extra-appendiceal primary tumors metastasized. None of the appendiceal tumors was malignant. One of the extra-appendiceal metastasizing tumors was multiple with a probable primary seat also in the appendix. The authors assumed that the metastases occurred from the extra-appendiceal primary carcinoid in the ileum and not from the appendix. Ashworth<sup>1</sup> described the unusual locations of twenty-eight carcinoid tumors he collected. He found the colon to be the most frequent site of occurrence outside the appendix and the small intestine. There were eleven cases of carcinoids of the large bowel in this series. Only two of these involved the cecum. There were seven cases involving a diverticulum, six cases in the stomach, two cases in the gallbladder and two in the mesentery. In seven of the twenty-eight cases metastasis had occurred.

Carcinoid involvement of the cecum is rare. Potter and Docter<sup>8</sup> in 1944 reported a malignant carcinoid of the cecum with metastasis. Note was also made of four malignant cecal carcinoids reported previously.

Reitz<sup>2</sup> states that of 2,520 consecutive appendices removed surgically within a five-year period at the Sacred Heart Hos-

pital in Pennsylvania from 1940 to 1945, there was an incidence of 0.08 per cent carcinoids, 0.04 per cent carcinoids with malignancy and 0.08 per cent primary carcinoma. He also notes twenty-one previously reported cases of malignant carcinoids of the appendix and reports at the same time his own case of malignant degeneration of an appendiceal argentaffin tumor. In this case the appendix was removed before the lesion had metastasized to regional lymph nodes; it, however, had spread into the serosa and infiltrated the appendiceal border of the meso-appendix. It seems important at this point to mention the opinion of many investigators of this subject that so far as the metastasizing potentialities of appendiceal carcinoids is concerned these do not differ from carcinoids in other locations. They produce, however, symptoms of appendicitis and are frequently removed early before metastasis can occur; other carcinoids metastasize while locally "silent."

As for the pathologic aspects of the tumor involvement of the appendix produces a characteristic gross appearance so that the diagnosis may be made from gross inspection alone. The appendix is usually thickened and fibrotic. The lesion is usually near the tip and here one may see a nodular or bulbous swelling. The tumor is usually small, not exceeding 2 cm. in diameter. Cross section reveals a typical yellowish surface. While the tumor in the appendix is usually solitary, those occurring in the small intestine are frequently multiple. Stevenson<sup>9</sup> reports one case in which sixty-eight discrete tumors were found in the ileum at operation. Neoplastic involvement of the small bowel frequently causes obstruction. This is apparently due in most cases to a kinking or angulation from mesenteric metastasis rather than to the actual tumor itself. The lesion seems to extend outward into the muscular coats rather than project into the lumen.

Microscopically, anastomosing cords of cells are seen. The cells are quite small, polygonal in shape and extremely uniform

in size. The nuclei are dark-staining, vesicular and rounded or ovoid. The cytoplasm usually has an indistinct border and is finely granular. Small droplets which take a lipoid stain can usually be demonstrated. Occasionally minute glandular spaces are formed lined by columnar cells but this is uncommon. The uniformity of the cells and the absence of mitotic activity and nuclear uniformity differentiate this tumor from carcinoma. A comparison of the histologic features in cases exhibiting metastases and those remaining as local tumors reveals no essential difference so that one can state only that all carcinoids have the potential power of metastasizing. According to Masson, the final histologic diagnosis of a carcinoid depends on the identification of the argentaffin granules in the protoplasm. However, many believe that this is not necessary. Forbus<sup>3</sup> and others believe that it is possible to make the differentiation from adenocarcinoma, for instance, on a purely morphologic basis.

Malignant carcinoid spreads by lymphatics and by venous invasion of tumor cells. While it should be pointed out that the tumor may thus metastasize and cause the patient's death, in some cases even though metastasis is present, the prognosis may still be good. This is due to the tumor's slow growth. Although local metastasis is common, generalized metastasis is rare. It should be stated that the presence of metastatic lesions should not prevent the surgeon from removing the primary site of the tumor. Mallory<sup>10</sup> refers to a case followed for twenty years after resection of a segment of ileum. "At the operation, metastatic nodes were noted deep in the mesentery. At the time of death from lobar pneumonia, they were still present but had not extended any further throughout that period." Stevenson's<sup>9</sup> case involved resection of the ileum for what was diagnosed adenocarcinoma of the carcinoid type with metastasis to the liver. Two years later the patient was noted to be doing well.

#### CLINICAL ASPECTS

Symptoms vary according to the region involved. In appendiceal carcinoid it is not unusual to find that the symptoms are those of typical appendicitis or, in the case of small bowel involvement, one may be presented with a picture of chronic intestinal obstruction. Anorexia and weight loss are common complaints. Upon examination one may occasionally palpate an abdominal mass. Blood in the stool is not common because of lack of ulceration of the tumor.

We wish to add the following case of malignant carcinoid of the appendix and the cecum to those few already reported. The case is interesting because of its rarity and because of the problem of determining the primary site.

#### CASE REPORT

The patient was a sixty-two year old white male who was admitted to Goldwater Memorial Hospital on May 21, 1946, with the chief complaints of dyspnea and swelling of both legs for four years, anorexia for one year and loss of weight for two years. He was well until he became ill in 1942 with bilateral ankle swelling and mild dyspnea. He was told he had heart disease. His symptoms abated somewhat when he went back to doing work that was less strenuous. In 1945 he noticed diminution of appetite, nausea, vomiting, weakness and a resumption of ankle swelling. He also observed occasional tarry stools. In September, 1945 the patient was admitted to St. Luke's Hospital in New York where a barium enema was given. Retrograde obstruction in the region of the hepatic flexure was demonstrated. A tentative diagnosis of carcinoma of the hepatic flexure was made. However, the patient subsequently left the hospital against advice. On December 7th he returned. Physical examination at that time revealed the abdomen to be soft; the liver was palpable four fingers below the costal margin. An irregular firm mass about the size of an orange was palpable in the right mid-abdomen distal to the liver. A repeat barium enema was given which confirmed the findings referred to previously. An exploratory laparotomy was subsequently performed. At operation the peritoneum of the entire right posterior aspect of the abdomen from the level of the inferior pole

of the right kidney to the pelvic brim was pushed forward by a large retroperitoneal tumor. This was biopsied and a large argentaffin tumor or possible metastatic carcinoma was reported. Although no direct involvement of the bowel was seen, the tumor had involved the mesentery of the ileum and the peritoneal attachments of the right colon to such an extent that it was thought that partial obstruction was undoubtedly present. For this reason an ileotransverse colostomy was performed. The patient made a relatively uneventful recovery except for a bout of pneumonia which was treated successfully. He was subsequently discharged to a convalescent home on January 3, 1946. However, he continued to feel badly with anorexia, vomiting and continuing weight loss. There was no diarrhea. He was subsequently referred to Goldwater Memorial Hospital because of cardiac decompensation.

At physical examination the patient appeared cyanotic and chronically ill, with wasting apparent about the upper part of the trunk. Blood pressure was 110/60 mm., temperature 98.6°F., pulse rate 100 per minute and respiratory rate 24 per minute. His chest revealed an increased anteroposterior diameter. The heart was enlarged somewhat to the left. A loud, rough, systolic murmur was heard at the apex and base and was transmitted to the great vessels of the neck. Bilateral pulmonary basal râles were heard. The abdomen exhibited a right, pararectal, incisional scar approximately 4 inches in length with a small defect in the lower portion. A mass was palpated in the right upper quadrant; it was difficult to determine whether or not it was an enlarged liver. There were no other masses palpated. The extremities exhibited a 4 plus pitting edema. Impression on admission was arteriosclerotic heart disease, chronic bronchitis and emphysema and abdominal malignancy with metastasis.

Laboratory findings revealed 4,000,000 red blood cells and 11,800 white cells per cm. The hemoglobin was 11 Gm. per 100 cc. Serum proteins were 6.5 Gm. per cent with an albumin globulin ratio of 2.6/3.9; the cholesterol was 162 mg. per cent and esters, 89 mg. per cent. The bromsulphalein test revealed no dye in the blood after thirty minutes. The van den Bergh, test direct and indirect, were normal. The blood Kahn was negative. X-rays of the chest revealed moderate emphysema and pleural thickening. The heart was slightly enlarged.

A gastrointestinal series was interpreted as revealing "an abnormal pattern of the small intestines." The cecum and ascending colon showed "irregularities which may be post-operative in origin."

The patient was treated for cardiac decompensation and improved considerably. However, on June 27, 1946, he signed himself out of the hospital. No more was heard of him until September 17th when he expired at home. The immediate events leading up to his death are not known.

Examination at autopsy revealed a bilateral pleural effusion. The lungs exhibited moderate congestion, edema, some atelectasis and chronic bronchitis. The heart was slightly hypertrophied and exhibited a localized fibrinous pericarditis. A chronic mitral and tricuspid valvulitis of rheumatic origin was present. When the abdomen was opened, 1,500 cc. of yellow fluid containing fibrin was found in the peritoneal cavity. The omentum was adherent to the operational scar; the peritoneum of the posterior abdominal wall was thickened. A side-to-side anastomosis of the terminal portion of the ileum to the transverse colon, forming an ileotransverse colostomy, was present. The mesentery was studded with small, yellowish nodules measuring approximately 1 cm. in diameter. The liver which weighed 1,660 Gm. and was brown in color extended two fingers below the costal margin. The surface presented whitish nodules which varied in size from 0.5 to 1 cm. in diameter. On cut section these nodules were seen to extend into the parenchyma for approximately 0.5 cm. The bare area of the liver was replaced by a white fleshy-appearing mass, approximately 8 cm. in diameter which penetrated deeply into the parenchyma. This mass was quite firm and in its central portion was seen a small, yellowish, friable area about 0.2 cm. in diameter. The remainder of the liver appeared to be grossly normal. The gallbladder showed no gross changes. The gastrohepatic ligament was markedly thickened and infiltrated. The upper gastrointestinal tract was not striking except for the ileotransverse colostomy referred to previously. In the region of the ileocecal junction posteriorly a large lymph node, 4 cm. in diameter, was noted which was quite firm and white in color. The appendix was retrocecal in position and was attached to the posterior wall of the cecum by thin fibrous adhesions. It meas-



FIG. 1. Islands of small dark-staining cells infiltrating the wall of the appendix. The cells are uniform in appearance. There is no tendency to form glandular structures. There is abundant connective tissue.

ured approximately 5 cm. in length and was kinked on itself in its central portion. It was moderately thickened and grayish-white in color. The cut section revealed a yellowish-white surface with a markedly thickened wall surrounding the lumen. Within the cecum on the posterior wall close to the region of the ileocecal valve, a tumor was observed which measured 5 by 4.5 by 2.5 cm. and was brown-red in color and cauliflower in shape. The mass was sessile and no ulceration was observed. There was only slight encroachment upon the lumen of the cecum; the remainder of the large intestine was normal in appearance. There was no evidence of a large retroperitoneal tumor as referred to in the report of the operation. There was a widespread involvement of the lymph nodes. The peribronchial, para-aortic and mesenteric glands were infiltrated and had a fleshy appearance. The remainder of the autopsy was not significant.

Microscopic sections of the appendix revealed replacement of much of the mucosa and submucosa with fibrous tissue. (Fig. 1.) There was infiltration with smaller and larger masses of cells of varying size separated from each other by fibrous trabeculae. The cells were of relatively uniform appearance small and dark with only slight variation in size, shape and



FIG. 2. The wall of the cecum invaded by sheets of cells which are of similar appearance as those in Figure 1.

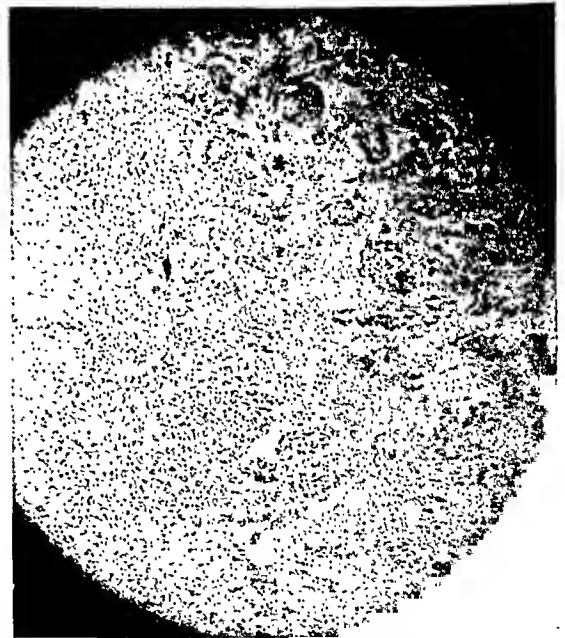


FIG. 3. Metastatic lesion in the liver; this section shows the presence of acinar structures and pseudo-rosettes.

staining characteristics. The nuclei were dark and pyknotic. The cytoplasm was eosinophilic and of moderate amount. The muscularis of the appendix was hypertrophied and the adventitia was thickened. These layers were also infiltrated with neoplastic cells but to a lesser extent. Section of the cecum exhibited replacement of the mucosa by fibrous tissue with many spaces seen in which sheets of small cells resembling those just described were found. (Fig. 2.) Collections

of these cells were observed in the muscular and adventitial coats. The adventitia was composed of dense fibrous tissue. The liver revealed in one area disruption of the architecture by large, patchy overgrowths of fibrous tissue. Moderate round cell infiltration and proliferation of bile ducts were evident. Several areas of hemorrhage were noted. In the region of the tumor the parenchyma was disrupted by malignant neoplasm. (Fig. 3.) This consisted of masses of neoplastic cells which had a tendency to form small acinar structures. Small groups of cells were seen infiltrating the fibrous stroma. Many dilated and congested capillaries were present. A section of the ileocecal lymph node showed complete destruction of the architecture with replacement by fibrous tissue. Within the latter masses of tumor cells were noted. Occasional giant cells with pyknotic nuclei were also observed. The capsule was invaded. Argentaffin stains revealed blackish-staining granules in the cytoplasm of some of the tumor cells. A diagnosis of malignant carcinoid of the appendix and of the cecum with metastases to the lymph nodes and to the liver was made. An incidental diagnosis of cirrhosis was also made.

#### COMMENT

The direct cause of death in this patient was probably unrelated to the tumor, presumably being cardiac in origin. It is extremely difficult, if not impossible in this case, to determine the primary site. The tumor may have been primary in the appendix and then metastasized to the cecum, liver and nodes. The possibility of the neoplasm being primary in the cecum with metastasis to the appendix appears less likely. Another reasonable explanation is that the primary site was multiple, arising simultaneously in the appendix and cecum. Certainly malignant carcinoid of the appendix is rare, Reitz<sup>2</sup> having reported the twenty-second case. Even more uncommon is malignant carcinoid of the cecum, Potter<sup>8</sup> having reported the fifth case in 1944.

#### SUMMARY

A review of the literature on carcinoid with a case of malignant carcinoid of the

appendix and of the cecum have been presented. Metastases to the lymph nodes and the liver were present. Although few cases of malignant carcinoids are reported in the literature, the tumor can no longer be regarded as invariably benign. The neoplasm is slow-growing and the presence of metastases should not prevent the surgeon from removing the primary site.

*Acknowledgment:* The authors wish to express their gratitude to Dr. Julius Rosenthal, Pathologist of Goldwater Memorial Hospital, for his kind assistance in the preparation of this paper.

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# PAPILLARY CYSTADENOMA LYMPHOMATOSUM\*

## BILATERAL INVOLVEMENT

HOWARD C. LAWRENCE, M.D. AND LEONARD PROCITA

*Columbus, Ohio*

*Ann Arbor, Michigan*

PAPILLARY cystadenoma lymphomatosum, or adenolymphoma of the salivary glands, has been the subject of several papers in recent years. It can still be considered a rather uncommon tumor. Albrecht and Artz<sup>1</sup> in 1910 first recognized this tumor as an entity. A review of the literature indicates ninety-one reported cases to date. Six cases of bilateral involvement were cited. The first bilateral case was reported by Nino<sup>2</sup> in 1941. Plaut<sup>3</sup> reported one case in 1942, Ramage et al.<sup>4</sup> one case in 1943 and Martin and Ehrlich<sup>5</sup> reported three in 1944. The latter authors reported 5 per cent of their series of twenty-two cases as occurring homolaterally multiple. We wish to report an additional case of bilateral involvement (in which multiple tumors presented on one side).

### CASE REPORT

The patient was a white male, aged sixty-one. He was seen on January 19, 1944, with the complaint of painless swellings of the face and neck. The mass in the left face had been present for two and one-half years, the one in the right neck for about six months.

The tumor mass in the left parotid (Fig. 1) occupied the central part of the gland. Its size was 6 by 4.3 cm. There was a second tumor immediately under the lobe of the ear on the same side which was 2.5 cm. in diameter and was definitely attached to the parotid gland. Both of these tumors were firm, were pseudo-fluctuant and were unattached to the skin or fascia. Two additional tumors were found on this side at the time of surgery.

The tumor mass on the right side (Fig. 2) presented in the neck anterior to the sternocleidomastoid muscle and extended from the angle of the jaw to the level of the upper border of the thyroid cartilage. The tumor meas-

ured 3.8 by 2.5 cm. It was fluctuant and freely movable.

Operation was performed on February 8, 1944, under local anesthesia. A preauricular incision was made on the left side. The capsules of the tumors were isolated below the capsule of the parotid gland. The large mass in the central portion of the gland was removed from beneath the trunk and branches of the facial nerve which were spread over its external surface after exposing the facial nerve and carrying the dissection into the gland proper for a short distance. The second tumor was removed after extending the skin incision onto the neck. Two additional tumors, measuring about 1.2 cm. in diameter each, were removed on this side. They were located deep in the gland between the ear and the large centrally located parotid tumor. The incision on the right side paralleled the jaw. The superior end of this tumor was attached to the parotid gland. The mass was removed intact.

The tumors were examined by the pathologist at Blodgett Memorial Hospital. The following are his findings: "Specimen consists of four masses of tissue from the left face and one from the right side of the neck. Each is well encapsulated though there are fibrous strands attached to the surface. One of the masses from the left and the one from the right are cystic and fluctuant. The former measures approximately 5 cm. across and contains thick, mucinous material. The latter measures approximately the same and contains thick, brown, putty-like material. The wall of the latter is thin and its lining is covered by numerous small papillary projections. One firm area is found in the wall and a smaller separate cyst is also present in the wall. The masses taken from the left are composed of soft, grey, friable, nodular tissue and even the more solid masses contain small cysts with contents similar to that described in the one which was completely cystic. The largest solid

\* From the service of Dr. Ferris Smith, Blodgett Memorial Hospital, Grand Rapids, Mich.



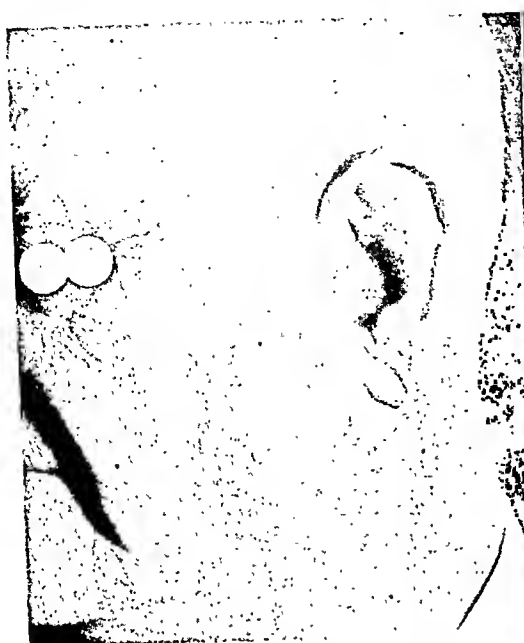


FIG. 1. Preoperative illustration of left-sided tumor.



FIG. 2. Preoperative illustration of right-sided tumor.

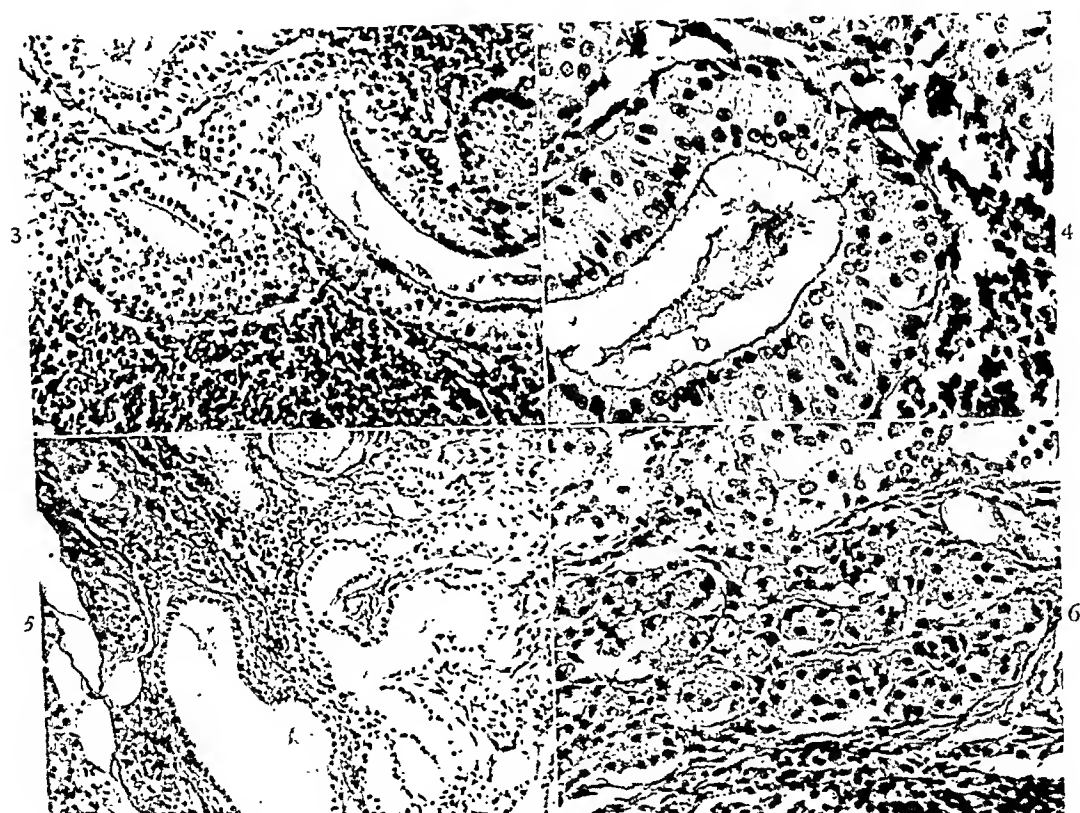


FIG. 3. General microscopic structure of tumor from left side. This shows characteristic epithelium, lymphoid stroma.  $\times 200$ .

FIG. 4. High power microscopic appearance of tumor from left side showing outer layer of tall columnar cells and basal layer of cuboidal cells.  $\times 440$ .

FIG. 5. Tumor from right side showing a more cystic structure.  $\times 200$ .

FIG. 6. High power photomicrograph of tumor from right side showing coarse granular appearance of cytoplasm.  $\times 440$ .



tumor measures about 5.5 cm. across. (Figs. 3 to 6.)

"Microscopic sections from the tumors from both the right and left side show essentially the same picture. The tumors are composed of normal appearing, well differentiated lymphoid stroma scattered throughout which are numerous glandular and cystic spaces outlined by a double layer of high columnar epithelium. In many of the cysts the epithelium projects in a papillary fashion. The lymphoid stroma lies immediately beneath the epithelium. There is no evidence of malignancy. In one or two regions some normal appearing parotid gland tissue is found around the periphery. Diagnosis: Papillary cystadenoma lymphomatosum."

#### COMMENT

The etiology and pathology of this tumor have been dealt with completely in the reports previously cited. The clinical features of this case are typical of this type of tumor. It is difficult to distinguish clinically from the more common mixed parotid tumor despite its morphologic entity. Ramage et al. quoted Carmichael and his colleagues with the statement that no record of correct preoperative diagnosis had

been made. The cystic tumor in the right neck was diagnosed preoperatively as a branchial cyst and the mass on the left side as a mixed cell salivary tumor.

#### SUMMARY

1. There were six previously reported cases of bilateral papillary cystadenoma lymphomatosum.
2. A case of bilateral tumors is presented, one of the side having four individual tumors.

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# SUBTOTAL CRANIECTOMY FOR OSTEOMYELITIS OF THE SKULL\*

DEAN H. ECHOLS, M.D. AND J. A. COLCLOUGH, M.D.

*New Orleans, Louisiana*

A CASE of osteomyelitis of the skull exhibited such remarkable pathologic and surgical features that its presentation seems warranted. Two interesting aspects of the case were the tremendous thickening of the skull and the progressive extension of the infection in spite of repeated surgical intervention. Only after almost the entire calvarium had been removed was the process arrested. This was probably a case of mixed infection as represented by the *treponema pallida*, *streptococcus* and *staphylococcus*. The salient features in the clinical picture were a positive reaction to blood tests for syphilis, spontaneous drainage of pus through the upper eyelids, palpable destruction of areas of the skull and striking roentgenologic evidence of sclerosing osteitis.

## CASE REPORT

C. L., a forty year old negro woman, was admitted to Charity Hospital in New Orleans on August 20, 1943, complaining of pain and swelling in the head, protrusion of the eyes and severe headache.

In March, 1943 the patient began to experience dizziness when she moved. In May, 1943 small swellings appeared in the region of the upper eyelids. These ruptured spontaneously and pus escaped from them at irregular intervals. These abscesses were accompanied by severe frontal headaches and the patient's eyes were said to have protruded. Previous to her admission to the hospital the patient had consulted a physician who evacuated a great deal of pus when he reopened the lesions. Two weeks prior to admission she had two attacks of "dizziness," each of which caused her to fall.

The physical examination revealed an undernourished negro woman with an enlarged and



FIG. 1. The destructive osteomyelitis appears to be limited to the frontal bone but the remainder of the cranial vault is thickened.

asymmetrical head. There was slight exophthalmus and the eyelids were edematous. Examination of the forehead disclosed a round, swollen, fluctuant area on the right side which was 4 cm. in diameter. Palpation suggested a defect in the underlying bone. A smaller defect was palpated on the left side of the forehead. The upper lids were marked by crusted areas from which pus could be expressed. There was neither pain nor tenderness. In addition to these lesions there were two fluctuant areas, one on each side of the midline just behind the hair line of the forehead. The pupils reacted to light and accommodation. The extra-ocular movements and the ocular fundi were normal. Vision was approximately normal. A 4 plus reaction to the Kline test was reported. *Staphylococcus aureus* was obtained by culture of the pus.

Roentgenograms of the skull showed areas of destruction and sequestration in the frontal bone; the skull was greatly thickened. (Fig. 1.)

After a brief course of antisiphilitic therapy and sulfathiazole a neurosurgical consultation was requested on September 1, 1943. The diagnosis of mixed syphilitic and pyogenic

\* From the Department of Surgery, Tulane University School of Medicine, Charity Hospital of Louisiana at New Orleans and the Section on Neurosurgery, Ochsner Clinic, New Orleans, La.



FIG. 2. Roentgenogram made five months after the one shown in Figure 1. Osteomyelitis has spread to involve the rest of the cranial vault.

osteomyelitis of the skull was accepted and operation was performed on the following day.

Under local anesthesia a coronal incision was made just behind the hair line from the right temporal to the left temporal regions, and the scalp and periosteum were retracted forward to the supra-orbital ridge. Defects in the outer table of the skull and considerable amounts of pus were noted. A trephine opening in apparently healthy bone was made and the greater portion of the frontal bone was removed with rongeur and Gigli saw. In the midline the bone measured 2.5 cm. in thickness. Both frontal sinuses were cleaned out and their openings into the nasal cavity were enlarged. A rubber tissue drain was brought out through each end of the incision and the scalp was loosely closed with silk sutures. Examination of the culture made at operation revealed the presence of anaerobic streptococcus, *Staphylococcus albus* and saprophytes.

After administration of sulfathiazole for three weeks there was almost no drainage from the wound but on September 30th, only four weeks after operation, roentgenograms showed areas of osteomyelitis in the parietal bones. On October 4, 1943, the patient exhibited a septic fever and there was an increase in drainage from both ends of the incision. Antisyphilitic treatment was resumed on October 5, 1943.

The second operation was performed on October 7, 1943. Under endotracheal anesthesia a sagittal incision was extended backward from the coronal incision for a distance of

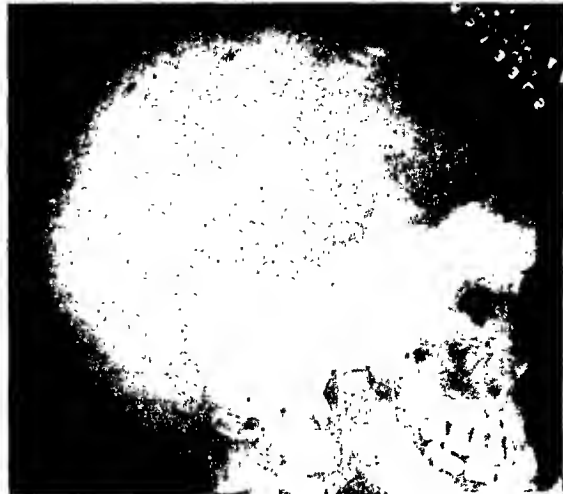


FIG. 3. Roentgenogram of the skull made after final operation. Little of the cranial vault remains.

about 7 cm. and the coronal incision was reopened. A considerable portion of the parietal bones was removed. The scalp was closed around rubber drains.

On October 11, 1943, the patient's temperature was normal and seven days later she was ambulatory. By November 17, 1943, the incision had healed completely except for a small granulating area in the left temporal region. The patient was discharged on November 18, 1943.

The patient returned to the hospital on February 12, 1944, because of severe frontal headaches which seemed to "push her eyes out." She also continued to have attacks of dizziness and on one occasion lost consciousness for an unknown period of time. For three weeks prior to this admission she had had fever and chills three or four times daily. A roentgenogram of the skull made on the date of this admission showed extensive osteoporosis and areas of destruction of the remaining portion of the cranial vault. (Fig. 2.)

At the third operation on March 9, 1944, the sagittal incision was extended to the external occipital protuberance, and a second coronal incision was made in the posterior parietal area. The remaining portions of the parietal bones and much of the squamae of the temporal bones were removed by rongeur and Gigli saw. The piece of bone removed with the saw measured 18 cm. by 10 cm. As far as could be determined at the end of the procedure all the infected bone and a considerable margin of healthy bone had been removed. A large epidural abscess and numerous sub-

periosteal abscesses were encountered during the operation. Drains were inserted and the scalp was closed. The postoperative course was uneventful.

Roentgenograms on March 25, 1944, showed that the remaining portions of the occipital and temporal bones were infected.

At the fourth operation on April 6, 1944, the incisions over the posterior part of the scalp were reopened and extended. The squamae of the temporal bones were rongeured away down to their petrous portions. The occipital bone was removed to and including the posterior margin of the foramen magnum. Postoperative roentgenograms showed that most of the cranial vault had been removed. (Fig. 3.) The wound healed so rapidly that the patient was discharged on April 11, 1944, the fifth postoperative day; she was referred to the out-patient clinic of Lafayette Charity Hospital for further antisyphilitic treatment.

On August 11, 1944, four months after the final operation, the patient was reexamined by one of us. She looked well and had no complaints. Her weight had increased from 85 to 120 pounds. The scalp and periosteum seemed to form an adequate support for the brain. The relative softness of her head seemed to give her some amusement.

On December 2, 1944, the patient was admitted to Lafayette Charity Hospital where she died the next day of pneumococcal meningitis. Necropsy showed an extensive, greenish-white exudate over the entire surface of the brain.

#### COMMENT

This case is presumably one of both syphilitic and pyogenic osteomyelitis of the skull. It presented, in addition to necrosis and abscess formation, a thickening of the bones of the skull which measured 2.5 cm. in one area. At these thickened sites the bone showed the solid structure of cortical bone without a diploic layer. Thickened areas alternated with spots of necrosis, large sequestrums and abscesses. The pathologic picture resembled both the acute and chronic forms of osteomyelitis of the skull as described by Mosher.<sup>1</sup>

As far as we know the cranial vault has never before been so extensively removed. It is remarkable that the absence of a cranial vault did not disturb the patient in any way. Her head was soft but the brain seemed well supported by the greatly thickened dura, periosteum and scalp. It is also noteworthy that the only thing that limited extension of the infectious process was its approach to the bones of the base of the skull. The fatal pneumococcal meningitis which appeared after more than six months of good health probably bore some relationship, although an obscure one, to the craniectomy.

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# TRAPPED FECALITH IN CECAL HAUSTRATION WITH LOCAL NECROSIS\*

CARL BLOTNER, M.D.

*Lawrence, Massachusetts*

OWING to the haustrations, the folds and the valvuli, the anatomic structure of the cecum is such, in certain individuals, as to favor the trapping of fecaliths. Such fecaliths, being unable to escape, become larger and may ultimately produce pressure necrosis of the cecal wall.

Presented herewith is the history and findings of such a case wherein a fecalith was found trapped in a haustration of the cecum by the valves and folds, with a resulting pressure necrosis of a small segment of the wall of the cecum.

## CASE REPORT

A white male fifty years of age entered the hospital on December 20, 1945, complaining of severe pain in the right lower quadrant of the abdomen. The pain began in the epigastrium two days prior to admission to the hospital and at that time was dull and aching in character. Several hours after onset the pain shifted to the right lower quadrant. The patient felt slightly nauseated but did not vomit. He consulted a doctor who advised immediate hospitalization. On the day of admission to the hospital the pain had become much more severe. The patient gave no history of diarrhea and had not noticed any blood or pus in his stools. There was no history of previous similar attacks and the patient felt perfectly well up to the onset of his present illness.

Physical examination revealed a well developed and well nourished male who was obviously acutely ill. The temperature on admission was 99.4°F. and the pulse was 90. There was no evidence of jaundice; the chest findings were essentially within normal limits; the blood pressure was 124/80. The abdomen was slightly distended and there was moderate

tenderness to pressure in the right lower quadrant, especially at McBurney's point. The right rectus muscle was slightly spastic, especially in its lower half. No masses could be felt. The liver, spleen and kidneys were not palpable. There was no tenderness to percussion over the kidney areas. On rectal examination there was moderate tenderness to pressure in the right side of the pelvis. Urinalysis was physiologic. The leukocyte count was 16,850, with a differential count of 80 polymorphonuclears and 10 lymphocytes. The hemoglobin was 89 per cent. A diagnosis of acute appendicitis was made and immediate surgery was recommended.

At operation the appendix was found to be normal and the distal portion of the ileum was normal. On the anterior surface of the cecum, at about the level of the ileocecal junction, an area of necrosis was noted which measured about 1½ cm. in diameter. This area of necrosis was very thin and was about to perforate. Surrounding the necrotic area there was a rim of inflamed, thickened cecum which measured about 2 cm. in width. Beneath the necrotic area there was palpated within the cecum a round, firm body about 2 cm. in diameter. Examination of the remainder of the cecum revealed no further pathologic condition and the appendix was removed. The necrotic area of cecum was excised and a segment of the inflamed rim was removed and sent to the laboratory for histopathologic study. On further examination the firm body felt previously was found to be a hard, black and brown fecalith. This was trapped in a pocket formed by a haustration and the valvuli coli and was unable to escape thereby producing localized pressure necrosis. There was no evidence of a diverticulum. A mushroom catheter was then inserted into the cecum and was brought out through the wound. The catheter was fixed in

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the cecum by means of two purse-string sutures.

Convalescence was smooth. The catheter was removed from the cecum on the sixth post-operative day in order to permit the cecostomy to close. During convalescence a barium enema was given which revealed no abnormality of the colon, other than the findings in the cecum which were due to the cecostomy. Proctoscopic examination revealed no pathologic disorder and stool examination showed no evidence of ova or parasites. The pathologist's report gave the diagnoses of gangrene of the cecum and atypical fecalith.

The patient was discharged from the hospital before the cecostomy had closed and was instructed to return after a period of four months for further check-up. Upon his return a repeat barium enema was accomplished and this re-

vealed essentially the same findings as on the previous examination, with the exception that the opening at the cecostomy site was about the size of a pin head.

#### SUMMARY

The haustrations, folds and valvuli of the cecum make the anatomic structure of this organ, in certain individuals, of such a character as to favor the trapping of fecaliths.

The history and findings of a case wherein a fecalith was found trapped in a haustration of the cecum by the valves and folds, with a resulting pressure necrosis of a small segment of the wall of the cecum has been presented.



ON the basis of experimental studies, Davis et al. believe that this antibiotic is a very helpful adjunct to surgery. In large enough doses it prevents perforation and gangrene of the devascularized bowel by controlling bacterial growth in said bowel wall. The authors believe this antibiotic is especially indicated in intestinal obstruction due to acute embolism or thrombosis of the mesenteric artery. (*Richard A. Leonardo, M.D.*)

# PSEUDOHERMAPHRODITISM\*

## REPORT OF TWO CASES IN THE SAME FAMILY

LEO F. BLEYER, M.D.

Madison, Wisconsin

THE term "hermaphroditism" originated in Greek mythology. According to the myth, the child of Hermes and Aphrodite showed male as well as female physical characteristics and was given, therefore, the name Hermaphrodita. That name has been applied ever since in medicine to individuals exhibiting certain features of both sexes in their physical appearance. True hermaphroditism is exceedingly rare in human beings and implies that the individual has both types of sex glands. The occurrence of hermaphroditic sex glands or ovotestes has been observed; secondary sexual characteristics in such persons may dominate in either sense and result in a peculiar combination of masculine and feminine traits. Much more common is the condition of "pseudohermaphroditism" in which the external genital organs and the psychophysis attributes are contrary to the sex glands and imitate more or less the opposite sex. It is assumed that the female sex in the human race is homogametic and the male sex heterogametic. The human ova contains the sex factor X. Spermatozoa carrying the X factor and impregnating the ovum produce a female individual with the genetic formula XX; spermatozoa containing the X factor besides the allelomorphic chromosome Y and impregnating the ovum produce the male constitution which is designated by the genetic symbol XY.

The formation of male or female sex glands is normally associated with the development of the homologous secondary genital organs and psychophysis properties. If, however, a *dissociation* of the inherited sexual constitution takes place

in embryonic life, the following developmental abnormalities may result: (1) The sex glands belong to one sex and the external genital organs or secondary psychophysis characteristics to the other. The anomaly is termed male or female pseudohermaphroditism according to whether the person has testes or ovaries. We speak of *complete* pseudohermaphroditism when the sexual glands belong to one sex and the external genitalia to the other. Various combinations may occur since the dissociation may take place in the entire sphere of physical and mental make-up. The sex glands and secondary sexual traits may belong to one sex and the external genital organs and psychical inclinations to the other sex; or all internal and external genital organs may be homologous and the secondary sexual properties be those of the opposite sex. Borderline cases may manifest themselves in unilateral gynecomastia or unilateral development of masculine growth of hair on the chest.\* (2) The dissociation of the inherited sexual constitution predominantly affects the psychic sphere and inverts sexual inclinations toward the same sex. Thus we arrive at a basic conception of genuine *homosexuality*. The sex glands and external parts belong to the same sex. On the other hand, many peculiar physical proportions have been found in homosexual individuals which more or less resemble those of the opposite sex. No sharp line separates the homosexual group from the hermaphroditic one. Zondek advanced the theory that the normal correlation between sex hormones

\* Quoted from H. Zondek's *Diseases of Endocrine Glands*.

\* From the Pathologic Department, St. Mary's Hospital, Madison, Wis.

and nerve centers is congenitally disordered and that the cerebral centers react to the hormonal stimuli in an abnormal manner, creating perverted sexual impulses. Cases of acquired homosexuality due to a structural abnormal sex gland or toxic personality changes, such as occur in cocaineism, have to be separated from the genuine form. (3) The sex glands and secondary sexual characteristics belong to the same sex but the accessory genital organs do not reach full maturity and remain at a hypoplastic level. This condition constitutes so-called sexual infantilism.

The classification of a pseudohermaphroditic individual as male or female is placed anatomically and medicolegally on whether or not the subject has male or female gonads. Such a criterion has the advantage of clear differentiation but is, nevertheless, an arbitrary standard from a one-sided viewpoint which does not cope with the problem of placing the patient properly in family, social and occupational relationship. In many cases the stigma of a hermaphrodite as male or female according to the sex glands runs contrary to the external appearance and the sexual and social inclinations of the person in question. The approach from a personalistic psychologic standpoint and the consideration of the total psychophytic pattern seems to be a better way for the practical purpose of a happy adjustment of the patient. These facts are illustrated by the following cases:

**CASE 1.** A white girl nineteen years of age and having seven adult sisters of normal development plus one younger "sister," was hospitalized because of a sudden attack of pain in left inguinal region, nausea, vomiting and headache. She had a small inguinal hernia since the age of eight. Whenever the patient strained herself by lifting or running, a small hernia about the size of a walnut would appear which she reduced herself. Upon admission a diagnosis of incarcerated hernia was made and a herniotomy performed. The hernial sac contained an encapsulated tumor nodule 2.5 cm. in diameter (Fig. 1) which was firm in consistency, presented a brownish-yellow cut surface and was con-



FIG. 1. Testicular adenoma of Case 1 removed the first time.

nected with a large blood vessel running through the internal ring into the abdominal cavity. Histologic examination of the herniated nodule (Figs. 2 and 3) showed a pronounced testicular pattern. The glands resembled well differentiated seminiferous tubules in lobular arrangement but without any evidence of active spermatogenesis. A pathologic diagnosis of testicular adenoma was made.

Physical examination of the patient (Figs. 4 and 5) revealed a general feminine body contour, face expression and fat distribution but a complete absence of axillary and pubic hair. The breasts were well developed. The vulva was infantile with poorly developed major labia. The clitoris was not enlarged. The vaginal opening admitted the middle finger and the vagina was short and narrow; portio vaginalis could not be visualized with a speculum. Vaginal smears stained by the iodine vapor test for estrogen evaluation showed glycogen deficiency of the epithelial cells. The patient had never menstruated in her life but was attracted sexually by males and desired eventual marital relationship.

About six months after the herniotomy the patient consented to an exploratory laparotomy for clarification of her endocrine status. A small



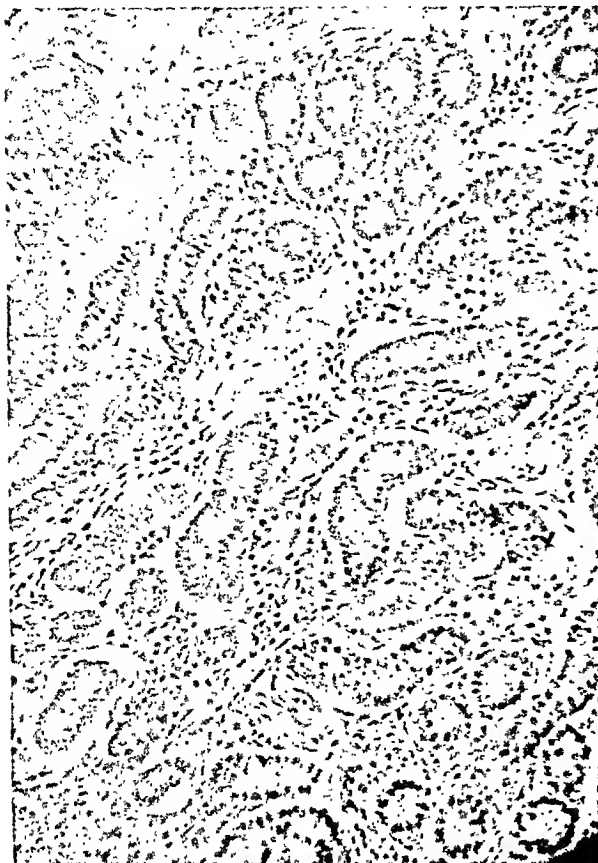


FIG. 2. Low power magnification of section of testicular adenoma, Case 1.

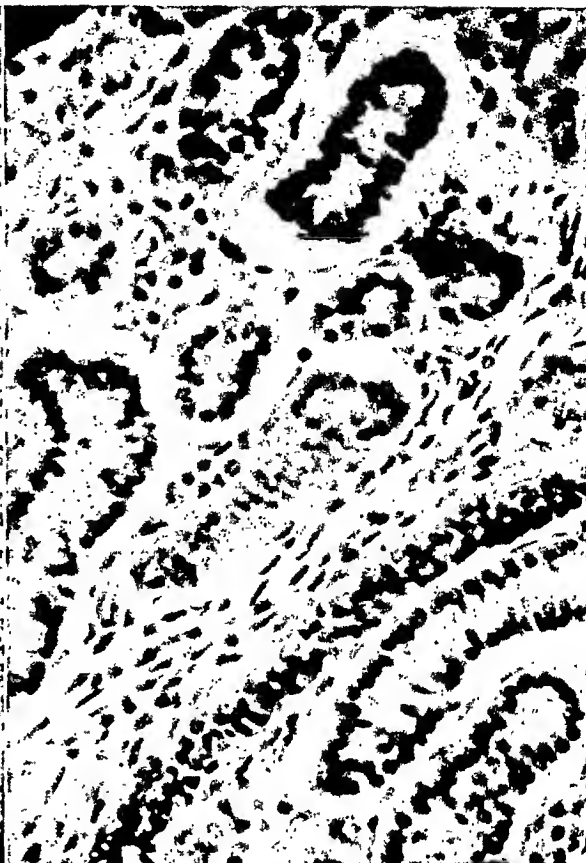


FIG. 3. High power view of section from testicular adenoma.

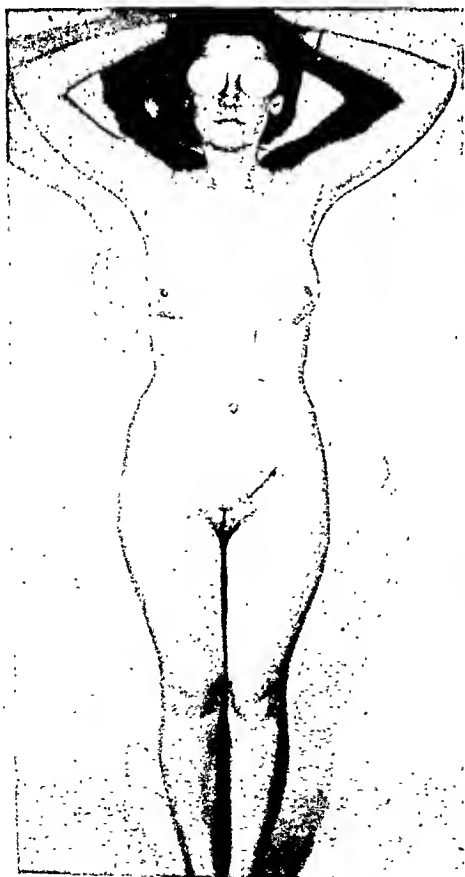


FIG. 4.

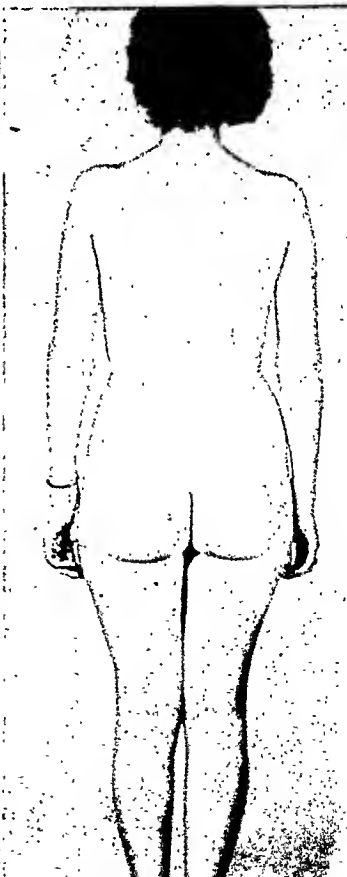


FIG. 5.

FIGS. 4 and 5. Case 1.



FIG. 6. Undescended right testicle, Case 1.

undescended testicle (Fig. 6) was found in front of the right internal inguinal ring which on cross section included three small adenomas resembling the nodule removed at the first operation and being identical in microscopic structure. There was complete absence of uterus, tubes and ovaries as well as prostate and seminal vesicles. In view of the general feminine physical and psychic make-up, the sexual inclination of the patient and the impossibility to promote development in a masculine direction it was decided to remove the testicle and to permit the patient to live the rest of "her" life as a female. It was believed that this would be in line with the predominance of female attributes in her total psychophysical personality. The anatomic diagnosis, of course, had to be that of a male pseudohermaphrodite.

CASE II. This patient was the younger "sister" of the patient in Case 1 and was twelve years of age. (Fig. 7.) She was brought up as a girl and acquired feminine traits through environmental influence. However, she showed a boyish facial expression, male hair line on forehead, hairy film on upper lip, broad

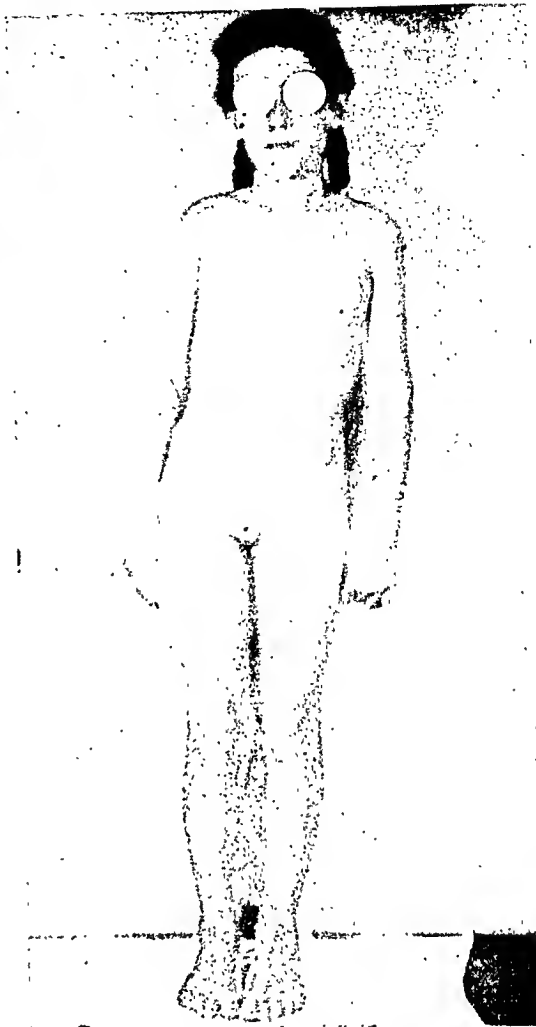


FIG. 7. Case 11.



FIG. 8. Low power magnification of undescended testicle, Case 11.

wrists, and flat nipples but normal female external genitalia corresponding to her age. She had a reducible right inguinal hernia for a long time. Consent for an exploratory operation was obtained under the suspicion that the child may have had the same abnormality as her older "sister." This expectation was confirmed by the finding of an undescended testicle (Fig. 8) in the inguinal canal; the other testicle was located at the left internal inguinal ring. There was no evidence of uterus, tubes or male ac-

cessory organs. Both testes were removed and a diagnosis of male pseudohermaphroditism was made.

#### SUMMARY

The problem of pseudohermaphroditism was discussed from a general anatomic, genetic and clinical standpoint. Two such cases in the same family were described as to clinical and anatomic findings.



PEDERSEN and Kenyon report a case of Cushing's syndrome in which a marked fuchsinophilic staining reaction of the surgically extirpated half of the enlarged right adrenal gland (found on exploratory operation) was the only positive pathologic finding present. After surgery the patient was given x-ray therapy to his pituitary gland and he was improved by this combined therapy (these are rare but interesting cases). One may suspect this syndrome when a woman develops rather sudden and painful obesity, especially of face, neck and trunk, early amenorrhea, increased growth of hair on face and body, diminished sugar tolerance, etc. (*Richard A. Leonardo, M.D.*)

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# Bookshelf Browsing

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## TODAY, YESTERDAY AND TOMORROW IN OBSTETRICS

ALFRED C. BECK, M.D.\*

Brooklyn, New York

ANNUAL reports of the obstetrical division of the Long Island College Hospital are quite like those of similar services. A brief survey of some of the statistics therein contained may be taken as representative of the obstetric end

TABLE I

LONG ISLAND COLLEGE HOSPITAL  
MATERNAL END RESULTS 1945 AND 1946

Admissions.....	3,624
Deliveries.....	3,360
Deaths.....	3 or 1 to 1,120 deliveries
Eclampsias.....	4 or 1 to 906 admissions

results of today. (Table I.) During the years 1945 and 1946, 3,360 women were delivered of children in that institution. Of these, three or 1 in 1,120 died, a maternal death rate of approximately 8.9/10,000 births. Among the 3,624 women who were admitted to the service, four had eclampsia and none of these died. The eclampsia incidence accordingly was 1 in 906 admissions. Of the 3,335 infants weighing 1,000 Gm. or over at birth, forty-four were stillborn and twenty-seven died in the neonatal period. The infant mortality including all pre-matures over 1,000 Gm., therefore, was 2.1 per cent. (Table II.)

TABLE II

LONG ISLAND COLLEGE HOSPITAL  
INFANT MORTALITY 1945 AND 1946

Infants over 1,000 gm.....	3,335
Stillbirths.....	44
Neonatal deaths.....	27

Total deaths..... 71 = 2.1%

One who has followed obstetric thought for the past thirty-five years, as the author

has, cannot observe this low maternal death and this low infant mortality rate without recalling the relatively poor end results which prevailed at the beginning of his obstetric career. When the writer entered the field of obstetrics, about one in every one hundred women delivered in our hospital died and over 6 per cent of the infants were lost. Eclampsia occurred once in every one hundred pregnancies and 20 to 25 per cent of the women so afflicted died. Women suffering from virulent puerperal infection were always on our service and hemorrhage of a serious nature was frequently encountered.

Although obstetric theory at that time was much as it is today, obstetric practice, at least from the standpoint of the community, was quite different. A few skillful obstetricians were then practicing in Brooklyn, but their number was small in comparison with the number who are doing fine obstetrics today. Of necessity most of the deliveries were conducted in the homes by general practitioners and midwives. As the number of hospitals with maternity services was small in relation to the total population the facilities for teaching practical obstetrics were limited. These practitioners had to learn the practice of obstetrics from their own experience. They thus learned by their mistakes at the expense of their patients.

Many of these men had entered practice directly after graduating from medical school without the advantage of an internship, their only experience having been the

\* Address of the guest speaker at the Joint Meeting of the Philadelphia, New York and Boston Obstetrical Societies held in Boston, April 15, 1947.

attendance at the six deliveries which were required by the State Licensing Board. In such circumstances the few well trained obstetricians who were available were kept busy as consultants. Unfortunately, these consultants often were called only after the patient's condition had become critical. As a consequence major operative procedures of a last resort nature frequently were required and even these, at times, failed to save the patient. In other words, the system then in vogue furnished woefully inadequate care for the average woman during pregnancy and labor but provided a few well trained obstetricians to act as consultants and rake the chestnuts out of the fire for their incompetent colleagues. Although the idea that the chestnuts might have been prevented from falling into the fire had already begun to dawn, there were no prenatal clinics until the first one was established in Brooklyn in 1912.

Even after our prenatal clinic was established most of the women delivered in our institution had had no prenatal care. They were either brought in by ambulance or were sent to the hospital by their physician or midwife after labor had been in progress for some time. I recall that it was extremely difficult and often impossible to make the women in our district understand the value of careful supervision during pregnancy. In fact, our clinic was more or less of a failure until we refused to accept cases for home delivery by our out-patient department unless they had attended the prenatal clinic. How different the situation is in this respect today! Thanks to maternity centers and other educational agencies it no longer is necessary to coerce women into accepting prenatal care. Most of them will not engage a physician for delivery unless he also includes this service.

Because of the lack of proper supervision during pregnancy and the early part of labor, the risk from cesarean section was great. Women with borderline contraction of the pelvis were given a thorough test of labor before interference was considered. Their labor was allowed to continue until

the cervix was fully dilated and several hours of good second-stage pains proved that the head would or would not enter the pelvis. If engagement failed to occur, the child frequently died before the test was completed and a craniotomy was done. If it was alive at the completion of the test and the head failed to enter the pelvis, it was delivered by cesarean section with the result that many of the mothers so treated died. Destructive operations accordingly were common and the members of our staff became skillful in their performance. Here again our practice at present is quite different. We now recognize dystocia early in labor and deliver such patients by cesarean section within the period which is safe for suprapubic delivery. The need for destructive operations is now so rare that we are unable to train residents adequately in the use of these procedures.

Eclampsia in those days was encountered about once in every one hundred admissions and probably was the most baffling of all the serious obstetric complications. Its frequent occurrence together with its high mortality of 20 to 25 per cent kept down the conceit of all obstetricians. While a man might have had the good fortune to get away with several successive cesarean sections on infected women, his luck always deserted him when he was called upon to treat eclampsia. The treatment of this condition at that time was so different from its present treatment that a brief description of the routine commonly employed in the old days may be of interest. The patient having one convulsion after another was wheeled into the delivery room. After taking a catheterized specimen of urine to confirm the diagnosis, preparations for immediate delivery were made regardless of the mother's general condition. Since the living products of conception were thought to be the cause of eclampsia, the removal of the child was our first consideration and took precedence over every other therapeutic measure. Whenever the cervix was sufficiently dilated, this was accomplished by forceps or

version and extraction. If the cervix was not sufficiently dilated, it was first opened by means of a vaginal hysterotomy, Dührssen's incisions or manual dilatation under general anesthesia. If the critically ill patient survived this hasty and traumatic delivery, she was subjected to the most inhuman eliminative measures. An intern inserted a stomach tube and began a gastric lavage while a nurse inserted a rectal tube and started the inevitable 20 gallon colonic irrigation. Following the gastric lavage, croton oil and castor oil or magnesium sulfate were left in the stomach. An attempt was then made to induce sweating by wrapping the patient in large, wet blankets wrung out of hot water, the so-called hot wet packs. As soon as one of the attendants was free he started a phlebotomy or gave veratrum viride. Although sedation was not considered an important part of the treatment, chloral hydrate and morphine were sometimes given. The student spectators who looked on while the nurses and doctors performed their various tasks often likened the spectacle to a three ring circus in which so much was going on at one time that much of it was missed. As I look back I often wonder how any of those eclamptic patients survived the treatment much less the disease.

Thirty-five years ago women were allowed to suffer throughout most of their labor. Only during the latter part of the second stage was relief of pain attempted by administering chloroform during each uterine contraction. Today relief of pain is one of the chief considerations of all obstetricians and most women are relieved of most of their pain with safety. While I was still a resident, the twilight sleep frenzy descended upon our clinic as it did upon many others. The fact that a woman could sleep throughout her labor and awaken after the child was born with no recollection of any suffering had a great appeal. Women in general became enthusiastic about the method and demanded its adoption by the medical profession. Although this method of securing analgesia

and amnesia proved less safe than it was hoped, it contributed toward the advancement of obstetrics in several ways.

Because of the close observation required and the seemingly miraculous end result obtained in most cases, the public came to regard the obstetrician in a new light. Instead of looking upon him as an idle bystander who patiently stood by while nature did its work, he was regarded as one who worked wonders in every patient he attended. Thus obstetrics was clothed with a new dignity which approached that which invested surgery. The greater appreciation of and the increased demand for good obstetrics thus engendered encouraged many young men to seek adequate training in obstetrics.

While the use of morphine and scopolamine according to the twilight sleep routine was found to be unsafe and was abandoned by most clinics, the value of these drugs was clearly demonstrated with the result that their continued use within the limits of safety has relieved much of the pain of childbirth. Even though it was ultimately abandoned the twilight sleep movement must be credited with having given a new and strong impetus to the search for an ideal method of pain relief, a search which has borne much fruit and continues to do so to this day.

Finally it may be said that even though its main objective, the complete elimination of pain without risk, was unobtainable the twilight sleep propaganda focused the attention of women in general upon the entire subject of maternal welfare, and thereby brought new and vigorous support from without to those obstetricians who were crusading for better obstetrics.

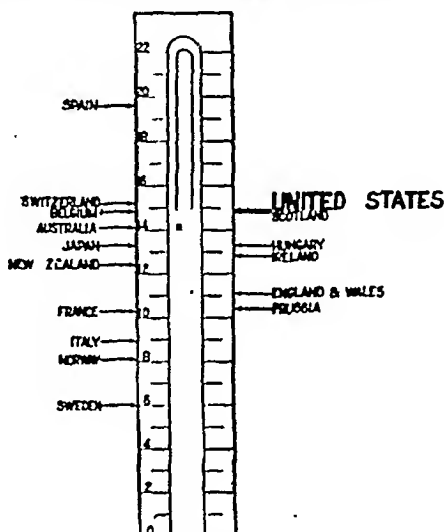
Within a short time after its establishment, the prenatal clinic demonstrated its value and the end results in the patients that entered the hospital from this source were excellent. On the other hand, neglected patients from the outside continued to be admitted and the poor outcome in many of them kept our gross maternal and fetal mortality high. This division of our

patients into two classes fostered the development of a peculiar two-sided attitude in us, in that we accepted full responsibility for the good results in our prenatal clinic subjects but refused to share the blame for the poor results in the others. We thus were

claimed that the data from the other countries should not have been compared with ours because of the lack of uniformity in the methods of assembling mortality statistics. Holding that our figures included all deaths from abortion, extra-uterine pregnancy

### MATERNAL MORTALITY THERMOMETER

AVERAGE DEATH RATE PER 100,000 POPULATION FROM CONDITIONS RELATED TO PREGNANCY AND CHILDBIRTH, 1900-1910



The United States lost over 16,000 women in 1916 from childbirth. We have a higher maternal death rate than any other of the principal countries except Spain or Switzerland.

CHILDREN'S BUREAU, U. S. DEPARTMENT OF LABOR.

FIG. 1. Maternal death rate per 100,000 population in the United States compared with that in other countries. (Children's Bureau, U. S. Department of Labor.)

quite well satisfied with ourselves and believed that we were doing all that could be expected of us. Unfortunately, a similar narrow attitude seemed to prevail in all of the clinics with which I was familiar. This complacency, however, was severely jolted in 1919, when the Children's Bureau of the Department of Labor published a pamphlet which showed that the maternal death rate was higher in the United States than in almost any other country. (Fig. 1.) The contrast between the lower death rate of 2.5/1,000 in Sweden and our high rate of 7.3/1,000 was emphasized, and Sweden was held up before us as a paragon of efficiency.

Prominent obstetricians everywhere rushed to the defense of the American system or, shall I say, lack of system. They

and intercurrent disease while those of many other countries did not, these men denounced their critics for introducing superficial and untrustworthy evidence to defile the good name of American obstetrics. Even Dr. DeLee, who always was a crusader for better obstetrics in this country, made the statement that anyone who claims that the United States is sixteenth or eighteenth in the list of countries in maternal mortality is guilty of treason. The critics, on the other hand, contended that the midwives in Europe were well trained and under the supervision of the state, and that their practice accordingly had been made safe for the mothers and babies. As a result of the ensuing agitation, Congress passed the Sheppard-Towner Act

in 1921, which made available to the states over \$1,000,000 annually for the promotion of the welfare and hygiene of maternity and infancy.

The controversy over the difference between the statistical data of this country

death rate in the fifteen states remained 57.6/10,000 live births. (Table III.)

Similar conclusions were reached by the Committee of the New York Academy of Medicine which investigated the deaths which occurred in New York City during

CHART 1.—STATES INCLUDED IN MATERNAL-MORTALITY STUDY

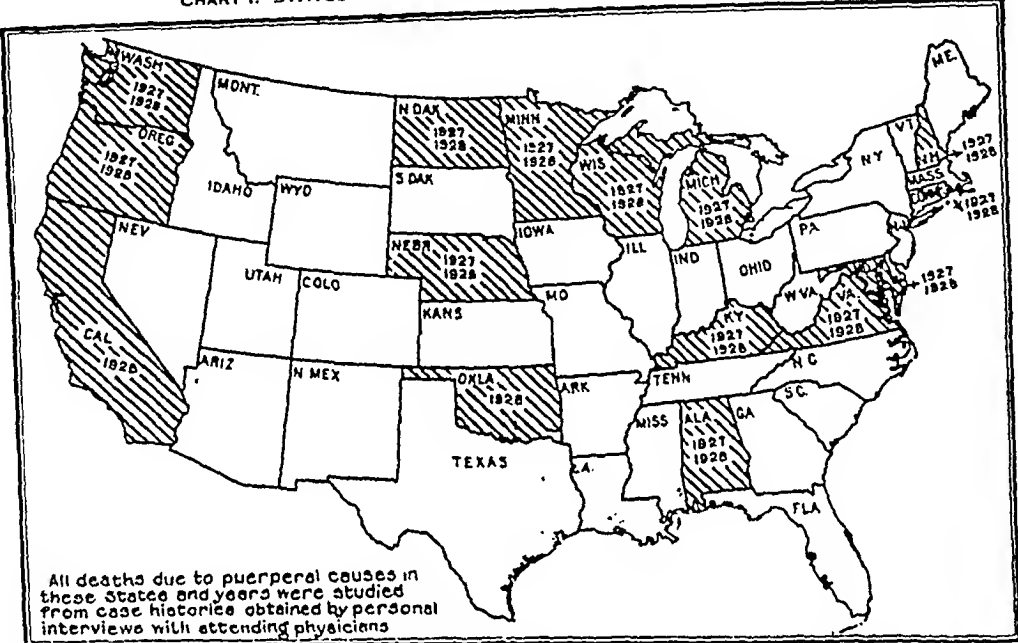


FIG. 2. Shaded areas represent the states in which the maternal deaths were personally investigated. (Children's Bureau, U. S. Department of Labor.)

and that of other countries led to a more comprehensive survey of the situation by the same Children's Bureau. Investigators were sent out to interview the physicians and midwives who attended all of the women who died from puerperal causes during the years 1927 and 1928 in fifteen states. (Fig. 2.) Under the supervision of an advisory council of well known obstetricians the data furnished by the original death certificates was reclassified with the result that the death rate as determined by this investigation differed but slightly from that which was based upon the original death certificates. According to the original certificates, the rate was 64.1/10,000 live births. This was reduced to 62.7/10,000 by the investigation. Deaths due to abortion and extra-uterine pregnancy totaled 5.1/10,000. If these are deducted from the 62.7 figure, the

the years 1930, 1931 and 1932. This investigation also showed that 65.8 per cent of the deaths were preventable and that the attending physician or midwife was re-

TABLE III  
MATERNAL DEATH RATE PER 10,000 LIVE BIRTHS  
FIFTEEN STATES 1927 AND 1928

	According to Death Certificate	According to Investigation
From all causes.....	64.1	62.7
Abortions and ectopics.....	5.3	5.1
Exclusive of abortions and ectopics.....	58.8	57.6

sponsible for 61.1 per cent of these preventable deaths. The work of this committee was a most significant step in the right direction. Instead of defending our end



results they reported that our death rate was almost three times as high as it should have been and that the physician was responsible for almost two-thirds of the preventable deaths. (Table IV.)

TABLE IV

NEW YORK ACADEMY OF MEDICINE SURVEY NEW YORK CITY DEATHS 1930, 1931 AND 1932	
Total deaths.....	2041
Preventable deaths.....	1343 = 65.8%
Physician responsible for 61.1% of the preventable deaths	

Following the publication of the Academy report, various county medical societies throughout the country made monthly surveys of the maternal deaths in their respective communities. The underlying factors in each death were thus brought to the attention of and discussed by the local members of the medical profession. These surveys accordingly served a dual purpose. They supervised the work of all who did obstetrics and at the same time inaugurated a new and excellent method of postgraduate instruction.

About this time a definite drop in the persistently high maternal mortality rate took place and this has continued up to the present. Between 1915 and 1933, the maternal death rate in the registered area of the United States remained above 60/10,000 live births. Since 1929, it has fallen progressively from 69.5 to 22.9 in 1944. (Fig. 3.)

In addition to the changes in the management of contracted pelvis and eclampsia already mentioned, many other advances have been made. Most notable of these were the efficient treatment of syphilis with arsenicals and penicillin, several improved technics for cesarean section, use of blood transfusions and the establishment of blood and plasma banks, substitution of rectal for vaginal examinations, prophylactic episiotomy and outlet forceps, development of x-ray pelvimetry, use of the sulfa drugs and penicillin in infections, discovery of the Rh factor and its application to obstetric practice and finally the various improvements in the methods of

pain relief. While these advances have contributed toward the improvement of our obstetric end results, they probably were responsible for only a small part of the progressive fall in the maternal death rate which has been observed since 1929.

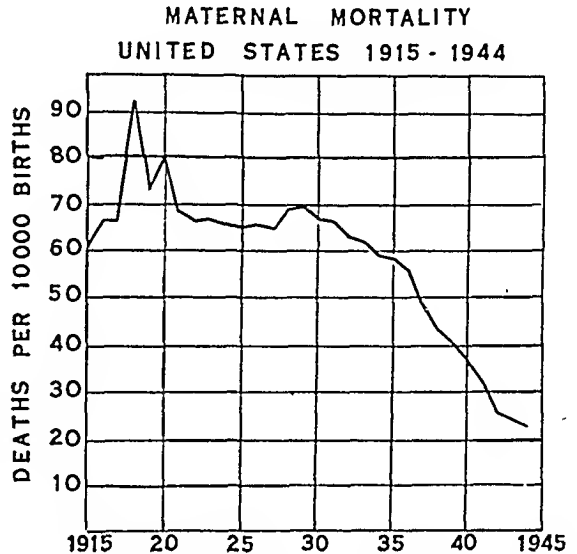


FIG. 3. Curve showing the annual maternal death rate in the United States from 1915 through 1944.

To my mind this improvement in our end results has been due largely to certain other factors. First of all it may be stated that the groundwork for this change was laid back in the twilight sleep days when the demand for better obstetrics began. Because of the lack of good obstetricians and because of the scarcity of maternity beds, this demand was not to be satisfied for many years. Every attempt to satisfy it, however, elevated obstetrics to a higher and higher plane is the estimation of the public and medical profession. As a result the obstetrician and his maternity service were no longer regarded as stepchildren of medicine but became important factors in hospital organization. Instead of being relegated to a corner of the building which could be used for nothing else, obstetrics was elevated to the level of surgery and was allotted more and more beds or even furnished with a new and separate pavilion. In 1946, there were 2,136,373 births in hospitals in the United States. In those

institutions which did not provide a separate maternity building the department of obstetrics ultimately was allowed to segregate its patients on a special floor or in a special wing and thus protect the maternity patient against infection by contamination from infected surgical and other patients and their attendants.

Obstetrics also rose to a higher estate in the medical schools. More hours were allotted and better instruction was given. This was particularly true of clinical or practical obstetrics. In most schools each student is now required to spend one or two months in the delivery room and maternity ward. The high regard in which obstetrics came to be held, together with its close affiliation with gynecology, led more young men to seek training in the combined specialities. With the building of more hospitals and the allotment of a greater proportion of their beds to obstetrics, many of these men were able to obtain one year straight internships and a smaller group were afforded the opportunity of serving two, three or even four years as residents. According to the Journal of the American Medical Association, 939 residencies were available in 1946. Some idea of the increase in the number of trained obstetricians may be gained from the fact that over 1,700 physicians were licentiates of the American Board of Obstetrics and Gynecology last year and these men were located in 300 different communities in the country. In other words, these fairly well trained young men, a new generation so to speak, have located in all parts of the country and are beginning to supply the service which the country has needed and the public has demanded for so many years.

At first glance one viewing the maternal and infant mortality figures of today might conclude that further improvement in obstetric practice is impossible. One maternal death to one thousand deliveries must be close to the irreducible minimum. On the other hand, all of us know that preventable deaths still occur in our own localities in which good maternity care is available.

Education of the public as to the need for early and special care in cardiac disease, nephritis, anemia and other medical complications, together with better coordination of the various factors which make up our present system of maternal care, should eliminate most of these preventable deaths and make the maternal end results even better than they are today.

While we may point with pride to our low maternal mortality, we may well question the quality of the end results as they are related to the newborn child. Since the premature infants who are too small to live together with the serious congenital anomalies make up over 1 per cent of all newborn infant deaths and since most of us believe that we are not responsible for the occurrence of these groups, obstetricians have come to regard an infant mortality of 2 per cent as close to the irreducible minimum. Our refusal to share responsibility for abortions, premature deliveries and the birth of serious congenital anomalies places us in the same position as were the older obstetricians who refused to share any part of the responsibility for the neglected patients who were sent into the hospital until others outside of obstetrics began to criticize the system for which they were responsible. When one woman of every fifty who carry to viability loses her child and at least one woman of every ten who become pregnant aborts, the end results are anything but good. If we as obstetricians are not responsible for this poor outcome of obstetric practice, who is? Certainly the woman who has no facilities for investigating her misfortune is not. I believe that the obstetricians of tomorrow will accept this responsibility and study the problem of abortion, premature labor and congenital anomalies with a view to bettering our end results of today.

Animal studies have shown that various deficiencies result in abortion or the premature birth of defective offspring, and recent observations have called our attention again to the injurious effect of virus disease on the young embryo. More infor-

mation of this character should lead to better management of the hygiene of pregnancy and thus lessen the number of abortions, premature labors and serious congenital anomalies.

Mall and Streeter, and more recently Hertig and Rock, have demonstrated the high percentage of early ova that are abnormal. These abnormal ova, especially the ones of Hertig and Rock which were obtained before or soon after the first period was skipped, indicate that either the spermatozoon or the ovum might have been defective at the time of fertilization. That this is possible is shown by the large number of abnormal forms that are present when the semen is examined in the course of our sterility studies. Such knowledge indicates that preconceptional advice that may result in improvement of the germ cell is important. These few instances of fruitful research indicate that future reduction of our infant mortality is a fertile field for further study.

X-ray pelvimetry when properly done is so superior to the older methods of pelvimetry that women in the future probably will demand and receive an x-ray investigation of their bony pelvis before they become pregnant. If the obstetricians of tomorrow are less narrow minded than the obstetricians of yesterday, they will assume the responsibility of providing facilities for this purpose in their respective communities. Supervision and proper evaluation of this work will thus remain where it belongs, in the hands of the obstetricians, even though the necessary funds for such a service may have to be furnished by the state or some other agency.

Future consideration should and no doubt will be given to the improvement of obstetric practice in two other important respects, namely, the development of a better method of controlling toxemia and

the development of a safe and satisfactory means of making labor an elective rather than an emergency procedure.

While our present system of prenatal care almost completely eliminates the danger of toxemia, this assurance of safety is accomplished only at the expense of great inconvenience to the patient. At present all pregnant women must make monthly, bi-monthly and finally weekly visits to their physician in order that the few who are destined to have toxemia may be discovered and given the special care which this condition requires. A better understanding of toxemia probably will enable the obstetrician of tomorrow to devise a more simple means of separating the few who are predisposed to this complication from the many who are not and thus greatly simplify the prenatal routine of the latter.

That our inability to judge just when labor will begin is the cause of much worry and inconvenience to the patient and her physician cannot be doubted by anyone who has practiced obstetrics. For weeks before and all too frequently for weeks after the expected date of confinement the patient and her physician must hold themselves in readiness for the event. If the patient lives some distance from the hospital, it may be necessary for her to spend these weeks of uncertainty in a nearby hotel to avoid the possibility of giving birth to her child in a taxicab. Discovery of the cause of the onset of labor and the invention of a harmless and efficient method of induction would greatly facilitate the adjustment of the time of labor to the convenience of the patient and her physician and thus make childbirth more of an elective than an emergency procedure. Just as most surgical operations are performed at a time of election so too labor would be started at a time which would be most convenient for all concerned.



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# The American Journal of Surgery

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A PRACTICAL JOURNAL BUILT ON MERIT

Fifty-seventh Year of Publication

VOL. LXXVI

NOVEMBER, 1948

NUMBER FIVE

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## Editorial

### PRESIDENTIAL ADDRESS

CASPER F. HEGNER, M.D.

*Denver, Colorado*

**S**ELF-PRESERVATION, the first law of animate creation, has a corollary, the relief of pain and the prevention of disability. During the dawn of civilization primitive care of the injured became the inception of surgery of a traumatic condition.

The surgery of an acute traumatic condition, the first and for many centuries the most important if not the only surgery, should today be the most advanced, the most highly standardized and the most efficient branch of surgery. Modern experience disproves this logical deduction. The surgery of a traumatic condition has not kept pace with the progress made in other branches of surgery. It lags because it is not receiving the consideration its universality and urgency demand.

The next surgical advance must be made in the field of traumatology. This is the prime purpose of our Association. To fully achieve this laudable purpose all factors pertaining to the prevention of accidents, and the general and local care of the injured must be explored, expanded and developed to the highest attainable degree.

Surgery in general, more particularly the surgery of traumatic conditions, is greatly indebted to military surgery. The experiences and techniques gained during the varied campaigns in the wars of many nations have proved their value through decades of civilian practice. Many surgeons became resourceful, versatile masters of emergencies under adverse

conditions and harrowing stresses incident to combat and during the confounding confusion attending the often unpredictable movement of large bodies of troops.

The plan first put into practice by Larrey during the Napoleonic Wars was developed into the most efficient program of all military history by the leaders of the United States Army Medical Corps during the late war—the on the spot first aid and protective treatment of battle casualties, the brilliant work of the unsung heroic stretcher bearers removing under fire the injured from the battlefield to the forward dressing stations for supportive therapy and imperative surgery, the prompt ambulance transportation to mobile field hospitals for emergency surgery and classification of injuries so that they may be distributed to base hospitals for definitive or specialized surgery and later if necessary to rehabilitation centers. This comprehensive and efficiently executed program established a record unequalled in military annals and unexcelled in civilian practice anywhere at anytime. The efficient care of the wounded is the only humanizing influence of wars. The care of the wounded by the Allies attained the ultimate in the late war.

Wars have taught that the surgery of traumatic conditions is not a specialty *per se*. It is basic. It is the vital part of every surgical specialty. It encompasses the whole body, covers every tissue, every system, every

cavity. Wars have taught that all who treat human ills or injuries should be qualified to handle traumas of any part of the body at least by adequate temporary protective dressings which would prevent additional damage or complications during transportation and until the time of receiving more efficient or definitive treatment. Furthermore, in the management of traumas no amount of definitive surgery however expert or highly specialized can achieve its best results without competent antecedent care. The best definitive surgery, the most ingenious revision operations cannot fully compensate for the damage compounded by or the complications consequent to overzealous, injudicious or careless early care.

These are the lessons the late war has taught. Are we to continue to be insensible to these invaluable experiences gained through suffering, blood and sweat and not apply them to the civilian teaching, training and practice of the surgery of traumatic conditions?

Modern traumatology, the science of wounds and injuries, presupposes a knowledge of anatomy, physiology, pathology and bacteriology. It imposes an accurate evaluation of the local damage, the reaction of the tissues in the area affected, an appreciation of the possible immediate and delayed complications and a careful consideration of the general physical and psychic reaction of the host to the local damage. It further implies an understanding of the nature, character, direction, duration, intensity and mode of action of the traumatizing force.

The modern treatment of trauma demands thorough, well organized instruction in the fundamental principles of surgery and adequate training experience in the application of these principles that can only be acquired under competent supervision in dispensaries and in receiving and accident wards of municipal, county and industrial hospitals where large numbers of all varieties and grades of casualties are received and treated.

The proper treatment of an acute traumatic condition is to do the correct and safe thing within the limits of one's ability under the limitations imposed by the existing circumstances. It may be (1) immediate or protective, (2) temporary or supportive, (3) delayed or corrective. Each is proper in time and place, each may be improper if time and place are ignored.

Most of our medical schools are woefully remiss in not giving well organized adequate instruction in the basic surgical principles which are fundamental not only to the surgery of traumatic conditions but also to all other branches of surgery. Many schools assume this teaching is sufficiently covered by the courses given in the surgical specialties. More time and attention is devoted to the elective surgery of comparatively rare and uncommon conditions, (gastrointestinal, cerebral, thyroid and chest lesions, tumors and specialized surgical operations) which is indispensable in the training of finished surgeons. These courses could be more advantageously confined to the years of graduate teaching after a thorough foundation in the basic surgical principles has been laid. Too much time and effort is expended on the superstructure and too little is devoted to the foundation of sound medical and surgical education, training and practice. The cursory manner in which these fundamentals are now generally taught is not conducive to good practice. Finished surgeons or specialists cannot be developed from a majority of the medical students in twice the time required for a medical degree. Neither can this be accomplished for the interested promising minority in the few years spent in the very best medical school.

The broader and better the general basic instruction and the more first hand clinical work during the school years the better will be the immediate general and any later special practice. The general practitioners are still the bulwark of better general health, the first, foremost and best defense on the skirmish line against disease and injuries. They constitute a group from which better specialists are recruited.

Each instructor of the surgical specialties plans his course on the erroneous assumption that the basic surgical principles have been previously taught by some other department. He teaches his special branch from the narrow view point of a specialist without regard to the fundamentals common to all branches of surgery. Both surgery in general and the special branches suffer by not being taught in the broader interest of better and more efficient service. The basic principles are the same for both but application of the details and technics differ. The surgery of traumatic conditions

which is highly individualized surgery suffers most by this discrimination.

The hospitals affiliated with medical schools stress training in elective surgical operations and those of the surgical specialties. This is imperative in developing specialists. Many of these hospitals do not have a sufficient number of casualties to justify a department or to allot beds for patients with traumatic injuries, without which they cannot give training or experience in the care of accident patients. There are many more minor injuries handled in a minor manner with major complications than there are major elective surgical cases treated in a major manner without complications. This emphasizes the fact that elective surgery is better taught and surgery of trauma is discriminated against by being poorly taught if taught at all. We must be belligerent against such discrimination.

A letter and questionnaire was sent to the deans of seventy-nine medical schools in the United States and Canada.

1. What provision has been made for the teaching of traumatology in your school [other than the lectures covered by general surgery?]
2. Have you any affiliated hospital facilities for regular or special classes for teaching, demonstration and treatment of acute injuries?
3. Would it be possible to have a special course in traumatology for the senior medical students?
4. Could it be arranged in your affiliated hospitals to have special service assignment in the care of accidents and injuries for
  - A. Externe Service
  - B. Interne Service
  - C. Resident Service
5. How much time is given to traumatology?
  - A. In the general surgical course
  - B. In special lectures
  - C. In hospital service.

Thirty seven did not reply.

Twelve returned the questionnaire stating they were not permitted to answer unless it had been approved by the Executive Council of the Association of American Medical Schools. Twenty stated there was no time in the already crowded curriculum and there was no service in their hospitals for the care of accident patients. Two stated they believed that trauma

was adequately covered by the surgical specialties and no special instruction and training was warranted. Eight medical schools fortunate in having affiliated hospitals with a large number of accident cases already have or are developing courses and services covering all phases of trauma.

TABLE I  
RESULTS OF ACCIDENTS OCCURRING IN FOUR MAJOR CATEGORIES AS TO ORIGIN OF ACCIDENT 1946

Origin of Accident	Result		
	Death	Disabling Injury	Permanent Impairment
Occupational industry..	16,500	2,050,000	90,000
Farm.....	4,500	320,000	46,000
Transportation.....	35,000	1,200,000	100,000
Home.....	33,000	5,000,000	130,000
Total .....	89,000	8,570,000	366,000

This apparent disregard of the importance of traumatology is incomprehensible since casualties far out number all other conditions requiring professional attention and accounts for a great number of preventable disabilities and deformities, avoidable deaths and fabulous monetary and economic loss. Injuries however expertly treated are the chief cause of costly, frequently unwarranted, litigation which often brings discredit, not only to the doctor who treated the patient but also to the entire surgical and medical profession.

This Association is guilty of grave negligence in failing to compel due consideration for the teaching of traumatology in all our medical schools and their affiliated hospitals. We should demand competent continuous supervision of acute traumatic conditions in all municipal, county and regional hospitals. The management and treatment of acute traumatic conditions demands versatility and resourcefulness, a greater degree of skill, more meticulous technique, better judgment, instant and prompt decisions to care for many types of injuries than that required in elective surgery. This is all the more momentous since accidents occur anywhere always unexpectedly. Many with serious, complex or multiple injuries occur

under circumstances and conditions in which facilities for treatment are inadequate or entirely lacking and trained personnel are not readily available.

Of the total estimated deaths from accidents in 1946 accidents in industry account for about

TABLE II  
MOTOR VEHICLE ACCIDENT DEATHS BY SIZE OF COMMUNITY IN WHICH ACCIDENT OCCURRED

Size in Community in Population	No. of Deaths	Per Cent of Deaths
Metropolitan (50,000 or over)....	7,250	21.5
Urban (2,500 to 50,000).....	5,250	15.6
Rural (less than 2,500).....	21,200	62.9
Total.....	33,700	100.0

16.5 per cent, in farm occupation 4.5 per cent, in transportation 35 per cent and in the home 33 per cent. Accidents in other settings account for about 11 per cent of the total.

The cost of accidents can be only roughly approximated, no information is available on the cost of occupational accidents on the farm. The estimated cost of injury is as follows:

Industry.....	\$2,400,000,000
Motor vehicle.....	2,200,000,000
Home.....	700,000,000
Total.....	\$5,300,000,000

If these costs are recomputed in terms of deaths in these categories, one can estimate that all accidents cost about \$6,300,000,000.

Thus almost two-thirds of deaths from motor vehicle accidents occurred in areas where there were no facilities for definitive care of injuries. Only one-fifth of deaths from motor vehicle accidents occur in communities where there is likely to be facilities to deal properly with all types of injuries.

Deaths from accidents occurring in rural areas constitute about 35 per cent of deaths from all accidental deaths. Teachers and surgeons working in the ideal environment of metropolitan or urban medical centers cannot appreciate the handicaps and limitations besetting those working in rural and remote areas.

We must develop plans to supplement the deficiencies in instruction in medical schools,

the lack of training experience in teaching hospitals and dispensaries, encourage the building and equipping of district, regional and community hospitals and supplying regional communities with readily available competent consultation service.

TABLE III  
DEATHS FROM ACCIDENTS OCCURRING IN RURAL AREAS

Type of Accident	No. of Deaths	Per Cent of Deaths
Motor vehicle.....	21,200	59.4
Home.....	10,000	28.0
Occupational (farm).....	4,500	12.6
Total.....	35,700	100.0

We are not interested in restricting the surgery of traumatic conditions to a few highly trained eminently qualified specialists. The surgery of traumatic conditions from the very beginning has been and will always be basic surgery. We are deeply concerned in broadening the field, stimulating interest, increasing the efficiency of all medical men from the metropolitan medical centers to the most remote and isolated areas of our country. This Association with propriety could publicize these meetings and welcome the attendance of the general profession thereby widely disseminating the benefits of these programs. Alerting the teacher and elevating the teaching standards is of vital importance; no less important is improving the care and treatment of those sustaining injuries not only in the metropolitan and urban centers but also those injured in accidents at the cross roads, on the highways and byways, in the homes, on the farm and ranches and in transportation by rail, auto or air throughout our land.

When complete attention cannot be given, it is more important and far better to know how and what to do to shield the wound and protect the patient without adding to the damage already sustained. The temptation to attempt too much is very great. Where but in the receiving and accident wards are students taught there are limitations beyond which one may not safely go, and are made to appreciate the invaluable limb and life saving restraint and self control imposed by these limitations.

There is a vast difference between good first aid on the spot, efficient emergency care which

is usually given by the local general practitioner and early competent definitive treatment rendered under more favorable circumstances. Each is absolutely essential to the best service of the injured. Only a small fraction of injuries if properly handled from their inception will require hospitalization. Only by competent application of the principles of care of injuries with due regard for details in the treatment of small wounds can complications be avoided. "Trifles make perfection. Perfection is no trifle."

In many casualties the injuries are multiple although only one, the most evident, receives attention. The others, frequently the more serious, are overlooked in a hasty or too casual examination. Where are students to be taught how to make a careful, gentle yet thorough examination of the seriously injured. Knowing how to transport a seriously injured person promptly, speedily, gently and safely to the nearest place where facilities and competent personnel are available for more efficient treatment without compounding injuries or adding to the shock, is often the best service that can be rendered. It may be life saving. Do medical schools give instruction in the very important phase of the management of trauma?

Since first aid is so important and proper transportation often demanded is so vital, a thorough comprehensive course in first aid should be given to every class in every medical school. These students when graduated will be qualified teachers of first aid and can give competent instruction to classes in high school and parochial schools, colleges, in every industry employing large numbers of workers, public utilities, mines, police and fire departments and transportation companies in the service clubs and other organizations. Teach first aid not as a hobby, not as a psychic sedative for distraught nerves during periods of national emotional distress but as a serious, continuing professionally and supervised program for responsible laymen everywhere.

Large industries learned long ago that accident prevention, first aid and prompt efficient care of injured employees pays.

Profiting by these experiences legislatures enforced installation of safety devices and the care of the injured in all industries large and small. Our Association should interest itself in directing, improving, if not actually participating in this movement of safety first.

Recently national legislation has been introduced to make this program part of the plan of compulsory health insurance. Unfortunately the general medical profession has not kept itself informed on this political trend. This Association should interest itself in the implications and inequities of current legislation. This is a must unless you want politically controlled, tax-burdened socialized medicine.

The tremendous number of accidents, the increase in gravity of injuries incident to our modern way of living, our prodigious industrialization, the mechanization of home, farm, ranch and city activities, the modernization and increase in speed of transportation obligates renewed attention upon the prevention of accidents, the protection of people and the more efficient care and prompt competent treatment of all types and degrees of injuries in order to better serve the public.

This compels the organization of an effective overall program of safety first; popularize first aid classes, demand greater consideration and stress in teaching fundamental principles of surgery and medicine in all medical schools, stress competent supervision of the training of students and residents in receiving and accident wards, make county, community and regional hospitals more accessible and provide qualified regional expert consultation service in order to avoid the appalling increase in casualties which are largely preventable, to reduce suffering, loss of time, disability, deformity and death.

We must be alert and become belligerently aggressive if we are to justify the function and purpose of our Organization. Our duty is clear, the task is great and the program formidable. With unity of purpose, we can accomplish great things for surgery and the better service for mankind.





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# Original Articles

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## TRAUMATIC RUPTURE OF THE GALLBLADDER AND LIVER

### REPORT OF A CASE WITH GENERALIZED BILE PERITONITIS

CECIL E. NEWELL, M.D.

*Chattanooga, Tennessee*

IN the absence of penetrating wounds of the abdomen, traumatic rupture of the gallbladder or liver is seen so infrequently that either condition is seldom suspected. When present, these conditions are sometimes masked by other more evident associated injuries. If diagnosis is not made, or at least suspected, the patient may succumb for want of proper surgery. The following case is reported with the hope of stimulating interest in these infrequent injuries and because no report of a similar case of rupture of both the gallbladder and liver resulting in generalized bile peritonitis can be found in an extensive search of the available literature.

#### CASE REPORT

M. W., 26173, a white male aged thirty, while intoxicated was riding in the front seat of a car being driven by another man who apparently was drunk also for it is said that they ran headlong into an embankment at a high rate of speed at about 1 A.M. on August 24, 1947. The patient was supposed to have been "thrown through the windshield." He was brought to the emergency room of the Baroness Erlanger Hospital at 2 A.M. and was treated by the house staff of the charity surgical service. He was bleeding profusely from many large lacerations of the face, forehead and scalp. His blood pressure was 140/100. Although drunk, he was conscious and complained of fullness of the bladder and an inability to void while his wounds were being sutured. He persisted in this complaint until surgery was interrupted and he was catheterized. Examination of this urine was negative. Suturing was resumed until he became pale, thirsty and complained of severe pain in his chest and lower abdomen and his systolic blood pressure fell to 102. He was given 500 cc. of citrated whole blood after which closure of his head wounds was completed.

The patient was put to bed at 3:30 A.M. His pulse was recorded at 100, blood pressure at

118/98, temperature 99°F. and leukocyte count 10,500. Wangensteen suction was instituted and 1,000 cc. of a 5 per cent glucose solution in normal saline was administered intravenously. This was ordered every eight hours. He was given 30,000 units of penicillin intramuscularly every three hours. He was ordered to have nothing by mouth but was found drinking the ice water out of his ice cap later in the morning.

X-ray films of his chest and abdomen taken on a portable machine were essentially negative. Because it was still suspected that he had a ruptured viscus, he was taken to the x-ray room and a roentgenogram of the abdomen with the patient in the upright position revealed no air under the diaphragm. After this no further mention was made on his chart of the possibility of such a rupture in spite of a rise in temperature and pulse, the development of colicky abdominal pain, generalized abdominal tenderness and rigidity, nausea, vomiting, distention and diarrhea.

When I first saw this patient sixty-six hours after admission, it was evident that he had a generalized peritonitis, most probably from a ruptured viscus, and he was immediately prepared for surgery. Operation was performed under spinal anesthesia. A right rectus incision was employed and the true nature of the rupture was guessed before the peritoneum was opened for it was stained a dark green. Upon entering the peritoneal cavity, thick, clear, green fluid gushed up into the incision. Approximately 3 pints were removed by suction. Exploration revealed every surface within the abdomen stained the same dark green. The gallbladder was found to be partially collapsed and bile was oozing through a diagonal tear which involved approximately two-thirds of its circumference, extending through the gallbladder bed and continuing upward as a vertical laceration of the liver through its anterior edge approximately 2 inches deep. Since it would have been very difficult to effect a leak-proof closure of the tear in both the liver and the gallbladder, it was considered best to remove the latter. This was accomplished from

below up, suturing the bed as the gallbladder was removed. The wound in the liver was easily closed with only two deep mattress sutures of chromic catgut using an atraumatic needle. The appendix appeared in the incision as closure was commenced so it, too, was removed. Five Gm. of sulfanilamide crystals were sprinkled into the abdominal cavity, a cigarette drain was left in the gallbladder fossa and the abdomen was closed in layers.

Recovery was prompt. The patient, fully ambulatory, was discharged from the hospital on his eighth postoperative day, the drain was removed on the eleventh day after operation and he was dismissed on his sixteenth postoperative day. He was last seen four months later, at which time he was in good health and working hard.

#### RUPTURE OF THE LIVER

Although solid viscera are more frequently injured than hollow ones<sup>92</sup> and the liver is thought by some to be the most frequent solid viscus to be ruptured by external trauma,<sup>25,26,49</sup> this injury is still rarely encountered by the average surgeon. Traumatic rupture of the liver is seen most frequently in the accident rooms of large urban hospitals<sup>87</sup> where its incidence is about 1 in 1,500 cases.<sup>87,92,102</sup> There are only ten proven cases in the records of the Mayo Clinic<sup>93</sup> before 1939. The right lobe is much more frequently ruptured than the left.<sup>7,62,91,102</sup>

There are three types of traumatic rupture of the liver which can be classified as follows: (1) Rupture of the liver and capsule; (2) subcapsular rupture, either of hepatic tissue just beneath the capsule<sup>79,80</sup> or separation of Glisson's capsule from the liver;<sup>66</sup> (3) central rupture.<sup>15,80,94,103</sup> By far the vast majority of ruptures of the liver are of the first type.

Without penetrating wounds of the abdomen, traumatic rupture of the liver is caused almost entirely from blows upon the abdomen by blunt objects or by squeezing or crushing trauma. Tangential force, carrying the organ beyond its limits of mobility, has been blamed for some lacerations of the liver, particularly the central ones.<sup>93</sup> Tortion, produced by rotating a child during delivery, is the cause of rupture of the liver which is occasionally seen in the newborn infant.<sup>55,71</sup>

Wright, Prigot and Hill describe four clinical types of cases of traumatic rupture of the liver: (1) Those with massive hemorrhage resulting in immediate or rapid death; (2) those with acute hemorrhage showing evidence of internal

hemorrhage and shock; (3) those with repeated small hemorrhages who became intermittently worse or suddenly change into the acute type and finally (4) those with little or no hemorrhage who usually undergo spontaneous cure.

Since intra-abdominal hemorrhage is the most common and pronounced finding in cases of a ruptured liver, those who are not killed outright demonstrate the signs and symptoms of this bleeding, which include pain, weakness, pallor, restlessness, dyspnea, rapid pulse, fall in blood pressure, shifting dullness, subnormal temperature, anemia and leukocytosis.<sup>7,52,101</sup> The patient may go into shock at any time. Nausea and vomiting are usually present. The vomitus may be bloody from hemorrhage through the biliary system.<sup>40,102</sup> If the patient survives a few days, a mild jaundice usually becomes manifest.<sup>90</sup> Abdominal tenderness and rigidity, more pronounced in the upper abdomen, is the rule. Right shoulder pain has been noted by several authors,<sup>23,53,69</sup> particularly when the dome of the right lobe of the liver is the site of the rupture. In some cases of subcapsular rupture the mass beneath the capsule has been palpated. Bradycardia has been observed<sup>30,33,63,90</sup> but most writers have not found it.

The diagnosis of a ruptured liver in the absence of penetrating wounds of the abdomen can be very difficult.<sup>23</sup> The most helpful findings are those of intra-abdominal hemorrhage with localization of the pain and tenderness to the right upper quadrant. If right shoulder pain is present, this is an added clue. The symptoms of rupture of the liver are almost indistinguishable from those seen in cases of rupture of the spleen. This makes little difference, however, for the indications for operation are the same in the two conditions. It is important to distinguish rupture of the liver from retroperitoneal hematoma for there is usually no indication for operation in the latter, yet the two conditions can easily mimic one another.

X-ray is of little value in the diagnosis of traumatic rupture of the liver despite its advocacy by Burke who uses thorotrast to visualize the outline of the liver in a four-hour diagnostic procedure. Following trauma to the abdomen, too much reliance should not be placed upon the absence of air under the diaphragm<sup>95</sup> for this merely rules out rupture of the gastrointestinal tract. It does not elimi-

nate the possibility of the presence of a rupture of either the liver or gallbladder.

Abdominal tap performed with a blunt spinal puncture needle in all four quadrants has been found to be very helpful in suspected cases of ruptured viscus.<sup>63,102</sup> This procedure is not without danger, however, as there have been fatalities reported from its use.<sup>38</sup> Peritoneoscopy has its proponents and opponents as has abdominal exploration through a tiny incision.

There is no agreement among surgeons on the indications for operation or on the optimal time for surgery.<sup>64</sup> It seems reasonable, however, to state that if the patient is in profound shock, it is wise to attempt to get him in a stronger condition by the use of transfusions, plasma, glucose and other antishock measures before operating. If no headway is made, surgery may have to be attempted anyway. On the other hand, if the patient is not in shock and symptoms point toward a cessation of bleeding, a conservative attitude may be taken and surgery postponed as long as the patient's condition progresses satisfactorily for spontaneous recovery from small ruptures of the liver definitely occur.

At operation the blood in the peritoneal cavity from a rupture of the liver should be removed and thrown away. Autotransfusion has been advocated in these conditions,<sup>3,97,100</sup> but it should not be performed because the presence of bile in the blood renders it toxic.<sup>52,102</sup> Death from anuria shortly after using such blood has been recorded.<sup>1</sup>

Many bizarre methods long since antiquated have been proposed to stop bleeding from the torn liver. They are too numerous to enumerate.<sup>2,4,14,17,32,73,89,93</sup> Despite popular belief to the contrary the best and most simple way to control hemorrhage from the liver is by simple and careful deep suturing, providing the laceration is accessible. If the laceration is too stellate or maccrated to suture or it is inaccessible, a hot wet pack held in place under pressure for ten minutes or more has been successful in arresting hemorrhage from the liver.<sup>52</sup> The pack should be removed if possible before the abdomen is closed<sup>70</sup> because there are numerous complications reported from packing wounds of the liver. A coagulum contact technic using fibrin foam, oxidized cellulose gauze, or "gelfoam" has lately been used with favorable results in ruptures of the liver.<sup>35,83</sup> Use of this procedure replaces the need for

packing with gauze. Any detached fragment of liver should be removed because of the toxicity resulting from necrotic liver tissue remaining in the abdominal cavity.<sup>6,36</sup> For the same reason all badly traumatized liver tissue should be excised. Branch resected approximately one-half of the liver that was badly torn in a child seven years of age without technical or clinical difficulty. Most surgeons are in accord that patients with a ruptured liver should have drainage for a few days, preferably with soft rubber tissue or a small cigarette drain. Sulfonamides, penicillin and streptomycin should be employed whenever indicated. A high carbohydrate intake has been found helpful in the convalescence of these patients.<sup>5,53</sup>

Traumatic rupture of the liver is a dangerous injury. All patients with massive hemorrhage die usually before surgery can be attempted. All of those with acute hemorrhage die if they are not given the benefit of surgery. The mortality in the group operated upon has been variously reported from 28<sup>42</sup> to 60 per cent,<sup>102</sup> a majority of observers reporting the mortality at approximately 40 per cent.<sup>46,49,66</sup>

Recently much has been written about the association of rupture of the liver with the hepatorenal syndrome, or "liver death," but Wright and his co-workers did not observe this in any of their thirty-two consecutive cases.

#### RUPTURE OF THE GALLBLADDER

Without penetrating wounds, rupture of an otherwise normal gallbladder is of very rare occurrence.<sup>51,56</sup> Reports of only thirty-three proven cases can be found in the literature,<sup>9,18,29,31,41,48,61,65,76,78,81,85,86,94</sup> most of these were collected by Lewerenz in 1903, Richetts in 1905 and Norgore 1946.

As with rupture of the liver the predominating force responsible for subcutaneous rupture of the gallbladder is a blow to the abdominal wall by a blunt object or a squeezing or crushing type of trauma. It must be extremely difficult to actually tear the gallbladder from external trauma unless it is distended at the time of injury<sup>65</sup> or the cystic duct is occluded by a stone<sup>85</sup> because this organ is so well protected beneath the liver. It is remarkable that none of the reported cases with a tear in the gallbladder had a simultaneous rupture of the liver.

There are two types of injuries of the gallbladder noted in the reported cases: (1) actual

laceration of the gallbladder wall and (2) "rupture" of the gallbladder from the liver. In this latter type the gallbladder is pulled away from its bed and hangs either by its neck<sup>61,81</sup> or is torn entirely from the liver and lies free in the abdominal cavity which Brown so aptly termed "traumatic cholecystectomy."

When the gallbladder is lacerated, bile escapes into the abdominal cavity and bile peritonitis ensues.<sup>72,84</sup> This is not such a catastrophe if it becomes walled off for localized pockets of bile can be well tolerated,<sup>27,65</sup> but if it becomes generalized, which is most frequently the case, it kills rapidly.<sup>13,19,24,54,65,88</sup> The introduction of even small amounts of bile into the peritoneal cavity will kill dogs and guinea pigs within twenty-four hours.<sup>43</sup>

The exact nature of the harmful effect of intraperitoneal bile is controversial. McLaughlin and others<sup>38,43,44,58,96</sup> believe it is due to the toxicity of its components, especially the bile salts and acids. On the other hand, it has been shown that following the introduction of bile into the abdominal cavity, ascites rapidly develops hence there is fluid loss from the circulation, sometimes enough to produce severe shock. Many believe this is the lethal factor in bile peritonitis.<sup>38,58,60</sup> Bacterial growth in the bile frequently complicates the chemical peritonitis and shock and this is thought by Mentzler and others<sup>54,75,94</sup> to be the chief cause of death in bile peritonitis. There is still another group<sup>57,74,94</sup> who have noticed a brownish fibrinous exudate covering the peritoneum of those in late stages of bile peritonitis. These observers believe death comes from blockage of the lymphatics by this exudate. It seems reasonable to assume that any combination or all of these factors may come into play in the fatal cases. But whatever causes death bile peritonitis carries with it a high mortality. It ranges between 50 and 75 per cent.<sup>54</sup>

The diagnosis of traumatic rupture of the gallbladder is more difficult to make than the diagnosis of rupture of the liver for the symptoms of bile peritonitis develop more slowly than the symptoms of intra-abdominal hemorrhage and shock is not as likely to appear as suddenly. The gravity of the situation, therefore, is more apt to go unrecognized in patients with traumatic rupture of the gallbladder, particularly when these patients are first seen. Bradycardia has been noted<sup>90</sup> but this is the

exception, not the rule. Mild jaundice from absorption of the bile from the peritoneum is sometimes perceptible within a few hours after the accident. Abdominal puncture confirms the diagnosis if bile or bile-stained fluid is obtained by this procedure.

The treatment of traumatic rupture of the gallbladder is definitely operative and consists of either suturing the tear or removing the gallbladder. These procedures are usually easy because the organ is not diseased.

The year 1898 marks the turning point in the prognosis of patients with traumatic rupture of the gallbladder. Before that date not a proven patient that suffered this injury recovered, either with or without operation.<sup>1</sup> In that year also was recorded the last death following operation. Every reported patient operated upon since has recovered.

#### SUMMARY

1. A case is reported of a patient with rupture of the gallbladder and liver without a penetrating wound of the abdomen who rapidly developed generalized bile peritonitis. This patient promptly recovered after the diagnosis was made and proper surgery instituted.
2. A review of the available literature reveals no previously reported similar case.
3. Rupture of the liver is a rare and dangerous injury. There are three clinical types. Symptomatology, diagnosis, treatment and prognosis are different in each type. A discussion of the problem is presented.
4. Traumatic rupture of the gallbladder is a very rare injury. Reports of only thirty-three proven cases can be found. This injury is usually characterized by development of a generalized bile peritonitis which is fatal unless it is remedied by surgery hence making the diagnosis becomes paramount.

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# PERFORATION OF THE SMALL INTESTINE FROM NON-PENETRATING ABDOMINAL TRAUMA

BOARDMAN MARSH BOSWORTH, M.D.

*Bronxville, New York*

PERFORATION of the small intestine as a result of trauma without penetration of the abdominal parietes is an unusual lesion but one which is apt to result in disaster if not diagnosed early and operated upon promptly. A recent case, fortunately with favorable outcome, in which perforation was not suspected for twenty-two hours prompted this search for similar lesions in the records of nearby hospitals and a review of the literature on the subject.

In 1935 Counseller and McCormack<sup>8</sup> reported on 1,313 cases which had been published up to that time. In their series the total mortality was 73.4 per cent and the operative mortality in the 887 patients explored was 60.7 per cent. Poer and Woliver<sup>27</sup> in 1942 added 199 cases by presenting 163 cases which had been reported subsequent to Counseller's series and thirty-six cases which they had gathered from the city hospitals of Atlanta and Cincinnati. The total mortality in this combined group was 61.2 per cent and the operative mortality 52.6 per cent in 1,58 patients explored. In both the Counseller and Poer reports perforations of the stomach and the colon were included but the number of these was so small as not to affect the statistical results materially.

This paper is restricted to perforations of the small intestine due exclusively to non-penetrating external abdominal trauma. The stomach and colon are excluded from consideration as are perforations due to muscle strain, water blast and pre-existing diseases of the small bowel. Congenital anomalies such as diverticula and hernias are included if perforation resulted directly from non-penetrating trauma. Apart from one or two references in the Russian, Turkish and Scandinavian literature, which were unavailable, seventy cases of this nature have been published from Poer's report<sup>27</sup> to July 1947. These seventy plus the eleven herewith presented for the first time form the basis of the present study.

## CASE REPORTS

CASE I. No. 230198, C. B., (N. Y. Hospital). At 6:30 A.M. on March 29, 1939, a fifty-six year old colored man tripped and fell on the street. He worked as a porter, the rest of that day and most of the next in spite of abdominal pain and vomiting. He was admitted to the hospital sixty hours after his fall in a critically ill condition, with a diagnosis of generalized peritonitis. His temperature was 39°C., blood pressure 95/75, pulse 100, white blood count 17,200; urinalysis was negative. Roentgenograms of the abdomen with the patient upright revealed no air beneath the diaphragm.

He was given adequate supportive therapy and within two hours of admission an exploratory laparotomy was performed by Dr. John Eckel. The abdomen was full of pus and undigested string beans. There was a gross, advanced, generalized peritonitis. A freely leaking 1.5 cm. perforation of the antimesenteric border of the ileum was found 3 feet from the ileocecal valve. A soft rubber tube was sewed into this perforation and brought out as a Witzel enterostomy. Gross debris was removed from the abdominal cavity; 4 Gm. of sulfanilamide powder were sprinkled about the site of perforation and the abdomen was drained through a lateral muscle-splitting incision. The patient died twelve hours after operation and postmortem examination confirmed the operative findings.

CASE II. No. 458359, M. S., (N. Y. Hospital). A forty-seven year old white male fell 20 feet into an open pit on October 9, 1946. He lost consciousness for ten minutes and was admitted to the hospital soon thereafter, still semi-comatose. His complaints were of diffuse abdominal pain and pain in the right shoulder.

Examination revealed the temperature to be 37.6°C., pulse 105, respirations 20, blood pressure 110/60. The patient was in acute pain, retching and vomiting. There were tenderness, spasm and rebound tenderness most marked in the left upper quadrant. The white blood count was 18,200 with 88 per cent polymorphonuclears. Urinalysis was negative except for a rare red blood cell and one to three white blood cells. Roentgenograms of the abdomen with the patient upright revealed no air beneath the diaphragm.



Supportive therapy was given and the patient observed, but as all signs and symptoms steadily increased an exploratory laparotomy was performed six hours after the injury by Dr. William Barnes. Fifteen hundred cc. of fluid and clotted blood were found in the peritoneum. There was a 1 cm. perforation in the antimesenteric border of the proximal ileum, with a rent in the mesentery which included a large ruptured artery. The artery was suture ligated and the perforation and tear closed with fine interrupted silk. No sulfonamides were placed in the peritoneal cavity and no drainage was instituted. Postoperative distention was controlled with Wangensteen suction, and the patient was discharged well on the fourteenth postoperative day. He was seen two months following operation at which time he was well and the gastrointestinal roentgenographic series taken then was negative.

CASE III. No. 423239, G. H., (N. Y. Hospital). On April 19, 1946, a piece of wood flew from a saw and struck this fifty year old white male in the right lower quadrant. He was knocked unconscious for a few minutes and when he came to had severe cramp-like pain in the right lower quadrant and right groin. He complained of frequency and slight dysuria. About twenty-four hours after injury he began to vomit and the pain steadily became worse. He was finally admitted to the hospital four days following injury.

At examination a lean white male, age fifty, lay quietly in bed with his knees slightly flexed. His temperature was 37°C., pulse 106, respirations 20, blood pressure 125/75. Movements of the trunk were painful. Eechymosis was seen in the right lower quadrant. Tenderness and spasm were present; rebound tenderness in the right lower quadrant was marked. The lower abdomen was distended and tympanitic. The white blood count was 6,300 with 83 per cent polymorphonuclears. The urine contained albumin 3 plus and was loaded with casts. Roentgenograms with the patient in the upright position revealed free air beneath both leaves of the diaphragm and distended loops of small bowel with fluid levels.

Promptly after admission an exploratory laparotomy was performed by Dr. Guy Maynard. An abscess pocket containing pus and feces was found in the rectal cul-de-sac, walled off by reddened loops of small bowel which were matted together with fibrin. There was 1.5 cm. perforation in the terminal portion of the ileum. It was closed with interrupted sutures of fine silk. Further exploration was not carried out because of the abscess. Four Gm. of sulfanilamide powder were sprinkled in the abdomen. Closure was effected with catgut in layers without drainage. The postoperative course was afebrile. The patient was discharged well on the twenty-ninth postoperative day. On follow-up

examination at nineteen months the patient complained of an occasional postprandial feeling of upper abdominal fullness. Examination was negative as was a gastrointestinal roentgenographic series taken at the same time.

CASE IV. No. 95394, J. P., (N. Y. City Hospital). While working, a twenty-four year old window washer fell two stories onto a fire escape and struck his abdomen against a large spike. He did not lose consciousness and he was brought to the hospital a short time afterward.

The patient was suffering from acute abdominal pain. There were generalized abdominal tenderness, spasm and rebound, greatest below the umbilicus. There was a superficial laceration of the penis. The patient was not in shock. A roentgenogram of the abdomen with the patient upright revealed air beneath the diaphragm.

A diagnosis of ruptured viscus was made and an exploratory laparotomy was performed by Dr. Roland Hipsley six hours after injury. A complete transverse rupture of the jejunum at the ligament of Treitz was found. The proximal end of the jejunum was inverted with a double layer of sutures and the distal loop of jejunum was brought out through the lower end of the incision. During the operative procedure the patient went into shock but was returned to the ward in fair condition. His postoperative course was stormy and nine days later at a subsequent operation 1 foot of gangrenous jejunum was resected and a pelvic abscess was drained. In spite of this he steadily became weaker and died on the twelfth postoperative day.

CASE V. No. 147098, J. C., (N. Y. City Hospital). A forty-three year old white male, who had been drinking heavily, fell on his abdomen at 1:30 A.M. on January 1, 1947. He was admitted to the hospital by ambulance about one hour later in a semi-comatose condition. There was a strong odor of alcohol on the patient's breath. There were generalized tenderness, spasm and rebound in the abdomen, greatest in the right lower quadrant. A roentgenogram of the abdomen with the patient erect revealed air beneath the diaphragm.

Thirteen hours after injury an exploratory laparotomy was performed by Dr. H. D. Stein. A 2 cm. perforation of the antimesenteric border of the ileum 9 inches from the ileocecal valve was found. This was closed with a simple inverting stitch and the abdomen was closed without drainage. The postoperative course was uneventful apart from a mild superficial wound infection. The patient was discharged well on January 25, 1947. He was readmitted on September 12, 1947, at which time an incisional hernia was repaired, and he was discharged well on September 25th.

CASE VI. No. 21722, J. S., (Grasslands Hospital). A forty-seven year old laborer was struck



in the right lower quadrant with the end of a crowbar while he was trying to move a heavy stone on May 20, 1935. He did not fall but had immediate abdominal pain and was brought to the hospital two hours later.

The patient was in acute abdominal distress, perspiring profusely, with agonized facies. His temperature was 98°F., pulse 70, respirations 20, blood pressure 120/65. Pain, tenderness and spasm were marked in both lower abdominal quadrants, greatest in the right lower quadrant. There was no rebound tenderness. The white blood count was 7,000 with 70 per cent polymorphonuclears. No x-ray was taken.

The patient vomited once after admission. He was kept under observation about eighteen hours and maintained a good pulse and blood pressure until the next morning when he went into shock rather suddenly. Exploratory laparotomy twenty-one and one-half hours after injury by Dr. Wilshusen revealed a 1.5 cm. perforation of the ileum at its juncture with the jejunum and generalized peritonitis. The perforation was closed and the abdomen was drained. The patient died of peritonitis and shock fifteen hours after operation.

CASE VII. No. 62782, M. M., (Grasslands Hospital). While riding a bicycle, a thirteen year old white male struck a stone wall on May 31, 1935. He did not lose consciousness and was admitted to the hospital within ten minutes of injury.

The patient was perspiring but not in shock. His temperature was 100°F., pulse 90, respirations 20, blood pressure 120/80. There was moderate tenderness of the entire abdomen and some voluntary spasm but no rebound tenderness.

The patient vomited several times and his abdominal signs increased during a few hours of observation. The white blood count was 18,000 with 85 per cent polymorphonuclears. No x-ray was taken. An exploratory laparotomy eight and one-half hours after injury by Dr. C. T. Smith revealed a rupture of the jejunum about 1.5 cm. in diameter. The perforation was closed and the abdomen drained. The patient had an uneventful recovery.

CASE VIII. No. 82715, E. R., (Grasslands Hospital). While working on June 3, 1943, a sixty-seven year old hospital porter was caught between two loaded stretchers and received a sharp blow across the lower abdomen. He complained immediately of severe, constant abdominal pain, weakness, dizziness and nausea. He was admitted to the hospital one hour after injury.

Examination revealed an elderly white male in acute distress. His temperature was 97.8°F., pulse 90, respirations 22, blood pressure 176/98. He vomited once during examination. There were generalized abdominal pain, tenderness, spasm and

rebound, greatest in the right lower and upper quadrants. Small reducible right and left inguinal hernias were present. The psoas sign was positive. The white blood count was 5,000 with 66 per cent polymorphonuclears. Urinalysis was negative except for a trace of albumin. X-ray of the abdomen with the patient erect failed to show air beneath the diaphragm.

The patient maintained normal temperature, pulse, respirations and blood pressure during the first seven hours of observation although he vomited once more, this time 300 cc. of chocolate-colored fluid with a small amount of bright blood. During the night, however, his condition rapidly deteriorated and in the morning it was believed that exploration would be fatal. The temperature had risen to 105°F. and the blood pressure had dropped to 56/40. He died twenty-seven and one-half hours after injury. Autopsy revealed a 1 cm. perforation of the antimesenteric border of the ileum at its junction with the jejunum. The perforated loop of bowel lay close to the right internal inguinal ring. An indirect inguinal hernial sac was found on the right side. There was generalized peritonitis.

CASE IX. No. 80505, E. T., (Mt. Vernon Hospital). A twenty-six year old carpenter was struck forcibly in the abdomen below the umbilicus with the edge of a large piece of wood. He vomited once and complained of abdominal pain and nausea.

His temperature was 97.8°F., pulse 88, respirations 20, blood pressure 140/80. There were generalized abdominal tenderness, spasm and rebound tenderness, especially below and to the right of the umbilicus.

Operation performed by Dr. Essrig on June 12, 1946, revealed a complete rupture of the jejunum 14 inches from the ligament of Treitz. The bowel ends were inverted and a side-to-side anastomosis was effected. The abdomen was drained. Time lapse from injury to operation was not recorded. Roentgenograms to show air beneath the diaphragm were not taken. The patient was discharged well four weeks after operation.

CASE X. No. 115642, W. D., (Mt. Vernon Hospital). A forty-one year old man was struck forcibly in the lower abdomen by a piece of wood which was kicked back by a circular saw. He collapsed and was brought promptly to the hospital. He vomited once.

His temperature was 101.4°F., pulse 130, respirations 26, blood pressure 122/86. There was slight ecchymosis of the skin over the lower abdomen. The abdomen was soft and not tender on admission but pain, spasm and tenderness developed later.

Operation performed about thirty-six hours after injury by Dr. Restin disclosed a ½ inch perforation of the jejunum 16 inches from the ligament of

Treitz and generalized peritonitis. The perforation was closed and the abdomen drained. The patient expired shortly after operation.

CASE XI. No. 66749, J. F., (Northern Westchester Community Hospital). A seventeen year old high school student was first seen by Dr. Donald W. Richie at his office in Croton Falls, New York, at 7 P.M. on October 10, 1947. Two hours earlier while playing football and blocking another player he had been struck hard on his left side and had fallen to the ground, striking his head. He was groggy but not unconscious and was able to walk off the field. When first seen his only complaints were those of headache and pain in the left side.

There was moderate tenderness in the left flank but not in the abdomen and the patient was not in shock. However, he was unable to void. During the trip to the hospital he was nauseated and vomited several times. Examination performed shortly after the patient's arrival at the hospital revealed moderate generalized abdominal pain, tenderness and spasm, with rebound tenderness, especially on the left side. Peristalsis was active. Examination of the central nervous system was negative. His blood pressure was 120/70, pulse 90, respirations 20.

At 9 P.M. patient was suddenly seized with excruciating abdominal pain. He voided a few minutes later with a marked decrease in pain. The laboratory findings at this time were as follows: Blood count: hemoglobin 108 per cent; red blood cells 4,880,000; white blood cells 18,700 with 76 per cent polymorphonuclears. Urine: 1.018; albumin 3 plus; sugar negative; microscopic: a few hyaline and many granular casts with 3 to 4 red blood cells per high power field. Roentgenographic studies of the abdomen, in both the supine and erect positions, revealed small bowel distention but no free air beneath the diaphragm.

At 7:30 A.M. the next day the abdominal pain and tenderness had subsided a considerable amount. There was some abdominal rigidity which was considered to be mostly voluntary. The white blood cells at this time numbered 21,500 with 90 per cent polymorphonuclears. In view of the patient's clinical improvement observation was continued.

At 3 P.M. on the same day the patient was seen in consultation. For the past three hours the pain, tenderness and spasm had increased. An exploratory laparotomy was therefore performed by me twenty-two hours after injury. A left upper rectus muscle splitting incision was made. The abdomen was full of bile-stained, cloudy fluid. The small intestines were matted together with fresh adhesions and covered with a fibrinous exudate. A 1 cm. perforation of the antimesenteric border of the jejunum was found 18 inches from the ligament of Treitz. Mucosa pouted through the perforation

from which clear bile-stained fluid still leaked. The hole was closed with a double layer of intestinal suture. Fluid was aspirated from the abdomen and a thorough exploration was performed, with no further evidence of injury. A culture of the abdominal fluid showed no growth in forty-eight hours. The abdomen was closed in layers with catgut. No sulfonamides were placed in the peritoneum nor was the abdomen drained. The postoperative course was entirely uneventful. The patient was out of bed daily from the first postoperative day. He was discharged on the tenth postoperative day free of symptoms.

*Incidence.* Among 40,000 admissions to the surgical service at St. Luke's Hospital, New York City, and 20,000 similar admissions to the White Plains (N. Y.) Hospital during the past decade no instance of non-penetrating abdominal trauma causing a perforation of the small intestine is recorded. (Table 1.) At Grasslands (N. Y.) Hospital three cases were encountered among 20,000 surgical admissions, at Mt. Vernon (N. Y.) Hospital two among 20,000, at New York Hospital three among 60,000 and at the New York City Hospital two among 20,000. Thus, in a survey of six metropolitan and suburban hospitals over a ten to fourteen-year period this lesion was encountered only once in every 10,000 to 20,000 admissions to the general surgical service, including the surgical specialties. Actually the incidence was probably much higher due to the difficulty of tracing such cases under the record systems used.

*Age.* In this series of eighty-one cases mortality seemed in no way related to age of the patient. Ages ranged from four to seventy-six years. The second, fourth and fifth decades were most frequently represented, accounting for two-thirds of the cases in which the age was stated.

*Trauma.* The main categories of trauma are listed in Table II. The type of violence which caused the perforation was interesting in several respects. Traffic injuries were the most frequent and included auto accidents of all kinds. Blunt blows were inflicted by iron bars, posts, chair legs and blocks of wood thrown by saws. Handles of cycles, wheelbarrows, shovels and stretchers caused injury when the patient was suddenly thrown violently against them. Of the four football cases one was due to a direct kick, another to a kicked ball, another to a tackle and the fourth

to an unknown trauma. It is noteworthy that in two cases the bowel was perforated during prolonged attempts to reduce an inguinal hernia in each instance by the patient himself. No direct relation could be found between trauma and mortality except that of the seven

transverse colon which has a redundant mesentery.

It is hardly surprising to find that in 82.2 per cent of all cases in which the tear was accurately localized (fifty-one of sixty-two cases) the lesion occurred at or close to a place where

TABLE I  
INCIDENCE OF SMALL INTESTINAL PERFORATION FROM  
NON-PENETRATING ABDOMINAL TRAUMA

Hospital	Years Covered	Approximate No. Surgical Admissions	No. Such Perforations Recorded
Grasslands.....	13 (1935-1947)	20,000	3
Mount Vernon. ....	10 (1937-1946)	20,000	2
New York.....	14 (1933-1946)	60,000	3
New York City.....	12 (1936-1947)	20,000	2
St. Luke's..... (N.Y.)	11 (1936-1946)	40,000	0
White Plains.....	10 (1937-1946)	20,000	0
Total.....		180,000	10

patients with severe multiple injuries, six of whom died, three without operation.

*Sites of Bowel Injury.* Table III shows the frequency with which the various segments of small intestine were involved, the specified sites of perforation or tear and the relative

TABLE II  
TYPES OF TRAUMA

Types	No. Cases
Traffic (automobile accidents).....	24
Blunt blow (wood, post, bar, etc.)....	21
Fall.....	11
Handles (cycle, barrow, shovel, etc.)..	10
Kick.....	8
Football.....	4
Crush.....	2
Unknown.....	1

mortality. The jejunum and ileum were about equally represented (thirty-eight and thirty-four cases, respectively). In only five cases was the duodenum injured. This low incidence of duodenal lesions may be due to deflection of the blow by the lower edge of the thoracic cage and perhaps some protection from the overlying

TABLE III  
SITE OF BOWEL INJURY

Site	No. Cases	No. Deaths	Mortality Per Cent
Jejunum.....	38	11	29.0
2 feet or less from ligament of Treitz.....	26	7	27.0
More than 2 feet from ligament of Treitz.....	4	1	
Not stated.....	8	3	
Ileum.....	34	14	41.2
3 feet or less from ileocecal valve.....	20	10	50.0
More than 3 feet from ileocecal valve.....	7	3	
Not stated.....	7	1	
Duodenum.....	5	2	
1st portion.....	1	1	
2nd portion.....	1		
3rd portion.....	1		
Not stated.....	2	1	
"Small bowel" (no site stated).....	4	1	

the bowel was firmly fixed to the parietes. In 86.6 per cent of thirty jejunal cases the perforation occurred within 2 feet of the ligament of Treitz while in 74 per cent of twenty-seven ilcal cases it was located within 3 feet of the ileocecal valve. This has been pointed out by others as an important mechanical factor in the production of bowel tears. In effect, the firmly anchored bowel is incapable of eluding a violent blow directed at it.

It has been stated that the mesenteric border of the bowel is most frequently torn.<sup>31</sup> In this series, however, cases were about equally divided as follows: antimesenteric border nineteen cases, mesenteric border fourteen cases, complete severance four cases. In forty-four cases the border was not specified.

As will be seen in Table III, the mortality rate was definitely higher in the ilcal than in the jejunal perforations, rising from 27.0 per cent for lesions of the upper jejunum to 50 per cent for those of the terminal ileum.

*Size and Number of Perforations.* The size of the bowel tear in these cases is analyzed in Table IV; 61 per cent (forty-two cases) were 1.5 cm. or less in diameter while 39 per cent (twenty-seven cases) were of larger diameter. Of the latter, three involved half the bowel

ture which involved three-quarters of the bowel's circumference.

Roentgen examination is an important part of the diagnostic survey for when it is positive much valuable time may be saved, and it should be performed whenever possible. At

TABLE IV  
SIZE OF TEAR

Size	No. Cases	No. Deaths	Mortality Per Cent
1.5 cm. or less (including so-called "small" tears).....	42	16	38.1
Over 1.5 cm. (including so-called "large" tears).....	18	6	33.3
One-half of circumference torn.	3	0	
Three-quarters of circumference torn.....	2	1	
Bowel completely severed.....	4	2	
Not stated.....	12	3	

TABLE V  
ROENTGEN EXAMINATION FOR AIR BENEATH THE DIAPHRAGM

Size of Perforation	Air Shown	Air not Shown	Total Cases	Percentage of Cases in Which Air Was Shown
Large tears..... (more than 1.5 cm.)	5	4	9	44.4
Small tears..... (1.5 cm. or less)	8	15	23	34.8
Size of tear not stated.....	3	4	7	
Total Cases.....	16	23	39	41.0

circumference, two three-quarters of the bowel and in four cases the bowel was completely severed. The mortality rate was approximately the same in both the small and the large tears except that two of the four patients in whom the bowel was torn completely across died. In each of four patients multiple perforations (two or three in number) of the ileum were found within 2 feet of the ileocecal valve. Two of these patients recovered and two died.

*Roentgen Evidence of Air beneath Diaphragm.* In thirty-nine cases roentgenograms were taken of the erect patient preoperatively to demonstrate air beneath the diaphragm. Air was revealed in sixteen of these cases, but in the remaining twenty-three no air was seen. (Table v.) Only five of nine patients with tears known to be more than 1.5 cm. in diameter showed air beneath the diaphragm by roentgenogram of the erect patient, and in only eight of twenty-three patients with perforations reported as 1.5 cm. or less in diameter was air seen. No free air in the peritoneal cavity could be demonstrated roentgenologically in one case twelve hours after injury although the bowel had been torn half-way through. Another patient had no air beneath the diaphragm as demonstrated by roentgenogram twenty-four hours following a rup-

ture which involved three-quarters of the bowel's circumference.

TABLE VI  
TIME LAPSE FROM INJURY TO OPERATION

Time	Total Cases	Deaths	Mortality Per Cent
10 hours or less.....	26	5	19.2
12 hours or more.....	37	13	35.1
Time not stated.....	12	4	
No operation.....	6	6	100.
Totals.....	81	28	34.5

*Time Lapse from Injury to Operation.* That the passage of time following perforation of a hollow viscus until operation is performed has a definite and vital bearing upon the patient's chances of recovery is well known. Six hours is usually taken as the longest period of delay for observation permissible when this condition is suspected. By that time a decision

should be made in most cases, for or against operative intervention.

The effect of delayed operative intervention in this series is shown in Table vi. Those patients who were operated upon twelve hours

which did not penetrate the abdominal wall are presented. An analysis is made of these and of seventy additional case reports published since the medical literature on the subject was last brought up-to-date ten years ago.

TABLE VII  
MORTALITY RATES

Series	Total Cases	Total Deaths	Total Mortality Per Cent	Patients Operated	Patients Died after Operation	Operative Mortality Per Cent
Counsellor and McCormack (1935).....	1313	965	73.4	887	539	60.7
Poer and Woliver (1942).....	199	122	61.2	158	81	52.6
Author's (1948).....	81	28	34.5	75	22	29.3

or more after injury had a mortality rate (35.1 per cent), nearly double that of the cases done within the first ten hours (19.2 per cent). Two patients, however, were operated upon as late as ninety-six hours, with recovery in each instance.

**Mortality.** Twenty-eight of these eighty-one patients died, a total mortality of 34.5 per cent; twenty-two of the seventy-five who were explored died, an operative mortality of 29.3 per cent. All six died who were not subjected to operation due to critical condition from multiple injuries.

Table vii sets forth the mortality rates in this and other series. It is not a true comparison for the other authors included perforations of the stomach and colon while the present series is restricted to perforations of the small intestine only. However, since in only 10 per cent of all cases<sup>8</sup> are the stomach and colon involved, it is believed that the figures accurately reflect a trend toward lower mortality rates in recent years. This should be so in view of the advances which have been made in the use of antibiotics, plasma and blood.

The mortality rates for this lesion are still too high. Patients continue to die because the possibility of perforation is not seriously considered or, having been considered, is discarded when the roentgenogram fails to show air beneath the diaphragm. Too much time is spent in wishful observation. In earlier diagnosis and surgical intervention lies our only hope of saving more lives.

#### SUMMARY

1. Eleven hitherto unreported cases of perforation of the small intestine from trauma

2. In six New York City and suburban hospitals a non-penetrating traumatic perforation was encountered only once in every 10,000 or 20,000 surgical admissions. On the other hand two cases were seen in one of these hospitals within a six-month period.

3. In most cases the injury was the result of a sudden, severe and unexpected blow to the abdomen by some blunt object. However, on two occasions it was caused by vigorous efforts on the part of a patient to reduce his own hernia.

4. Eighty-two and two-tenths per cent of perforations in this series occurred in or not far from a relatively fixed portion of the bowel.

5. The majority of tears were 1.5 cm. or less in diameter but there was little correlation between the size of the perforation and the severity of symptoms produced.

6. Roentgen examination of the erect patient failed to show air beneath the diaphragm in 59 per cent of cases in which perforation was proven by operation or postmortem.

7. The total mortality in this series of eighty-one cases was 34.5 per cent and the operative mortality 29.3 per cent.

8. Delay in operation was the most important single factor in causing death. After the first twelve hours following injury the mortality rate doubled.

#### CONCLUSIONS

Perforation of a hollow viscus must be suspected when there is persistent abdominal pain, spasm and tenderness, with or without nausea and vomiting, subsequent to severe trauma to the abdomen. If these signs persist for six hours,

exploratory celiotomy should be performed forthwith, regardless of failure to find free air in the peritoneum by roentgenography. Under such circumstances reasonable suspicion, as in acute appendicitis, not only justifies but demands immediate operation. The dangers of delay are far greater than the hazards of surgery.

Grateful acknowledgment is hereby made to Drs. George C. Adie, Nelson W. Cornell, Frank Glenn, William F. MacFec, Edwin G. Ramsdell, and Preston A. Wade, Chiefs of the Surgical Services at the following hospitals: Grasslands, Mount Vernon, New York, St. Luke's, White Plains and New York City, for their courtesy in making available the records of those institutions in connection with this study.

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## DISCUSSION OF PAPERS BY DRs. NEWELL AND BOSWORTH

R. ARNOLD GRISWOLD (Louisville, Ky.): The question of non-penetrating abdominal trauma is a very difficult one. The spleen, the liver and kidneys are perhaps the organs most frequently injured, but injuries to the hollow viscera are usually more difficult to diagnose and operation is therefore frequently delayed.

X-ray of these patients is likely to lead to a false sense of security since, as has been pointed out, in only a small percentage is the laceration productive of air under the diaphragm. The injury

is usually to the small bowel where it has a short mesenteric attachment, and in a considerable percentage of cases, may not involve immediate perforation of the bowel. There may be delayed perforation due to necrosis of injured bowel.

I have seen three cases in which the mesentery was torn from 6 to 8 inches of the upper jejunum or lower ileum without perforation at the time. Perforation, however, may ensue three, four or five days later from gangrene of the detached bowel.

In any suspected non-penetrating wound I believe it is safer to explore than it is to procrastinate in order to make a definite diagnosis. The risk of unnecessary exploratory operation, if the patient is out of shock, is certainly much less than the risk of delay in these cases.

The liver injuries that Dr. Newell mentioned are severe and I should like to stress one point that he made, and that is to avoid gauze packing. Gauze packing of a wound of the liver, in which the gauze is left in as a drain, is almost universally followed by live infection and secondary hemorrhage. These patients whose livers are packed with gauze will usually die a week or two later of secondary hemorrhage. The newer hemostatic agents, such as large sheets of gelfoam or the oxycel products are preferable to any type of permanent gauze packing.

Any dead liver with detached fragments which are deprived of their blood supply should be very carefully removed; since autolysis of liver tissue in the abdomen is not only extremely serious but frequently fatal, and is the cause of a great many cases of what we used to call the hepatorenal syndrome.

GROVER C. PENBERTHY (Detroit, Mich.): Both of these papers have emphasized the principles which are sound in the management of abdominal injuries of a non-penetrating type.

My discussion will be limited largely to Dr. Bosworth's paper in which he has shown the low incidence of this type of injury. He mentioned that in this study one out of 10,000 are injuries of this type of the small intestine.

The report of cases which I wish to add to Dr. Bosworth's collection are cases from the Detroit Receiving Hospital operated upon by members of the staff and two from the Michigan Mutual Hospital in Detroit.

For the study of these cases I am indebted to Dr. J. H. Posch, resident of the Receiving Hospital, who energetically surveyed the records of the Receiving Hospital. We find that our incidence of this type of injury is about one in 8,000 for hospital admissions and about one in 3,000 of surgical admissions.

In the study from 1935 to 1938 at the Receiving Hospital we had five cases which Dr. Posch was able to pick up. Since the advent of chemotherapy

in a similar three-year period from 1943 to 1946 we had eleven cases with three deaths. In a series of five cases prior to chemotherapy in 1935 to 1938 we had a mortality of 100 per cent, showing the seriousness of this lesion and the importance of early recognition.

LESTER BREIDENBACH (New York, N. Y.): At Bellevue Hospital on the 4th Division it is by far safer to come into the hospital with a gunshot wound or a stab wound of the abdomen than it is with blunt trauma to the abdomen, because the patient gets operation sooner, and therefore the mortality is less.

We have had six cases in the last twenty years in which the mortality was 50 per cent. The first case that I saw was twenty years ago. A fifty-five year old man, who was carrying a large, round cheese clasped on his abdomen and chest, tripped and fell on the cheese. It seemed like an insignificant trauma; the fall was not from a great height and yet he was put on watchful waiting for seventy-two hours and then died. Autopsy showed a complete transection of the jejunum about 12½ inches from the ligament of Treitz.

In spite of that experience we had other cases admitted, almost all with the same story: watchful waiting, delay in operation and death because of associated severe peritonitis and toxicity.

In the last two cases in more recent years, one had a duodenal injury and that was the only one of the six that showed air under the diaphragm. The jejunum and ileum cases did not show air under the diaphragm. The patient with a duodenal injury was operated upon seven hours after admission and did well. The sixth case was that of an ileum laceration, not transection; the patient was operated upon promptly and got well.

I think the main clinical picture is persistent pain, tenderness and leukocytosis with polynucleosis. If that is recorded and persists, I think it is a definite indication for exploration as early as possible.

Concerning Dr. Newell's paper, we have had one very interesting case of a transection of the common duct at the junction of the two hepatic ducts. This man was driving a truck in a high cab, was hit by another truck and somersaulted out of the cab of the truck, landing on his abdomen, hitting the front mudguard on the way down to the ground. He was brought to the hospital in slight shock, not very severe, but as time went on his abdomen became distended with fluid. He developed mild jaundice and at the end of sixty hours was operated upon. He had 3,200 cc. of bile in his abdomen, and this laceration at the junction of the common and hepatic ducts was found and repaired. He did well for a short period of time. He had about seven admissions to the hospital in the course of three years, each time with chills, fever, cholangitis and jaundice. On several occa-



sions he was not opened but was treated. The chills, fever and jaundice subsided and he would go along again for a time feeling pretty well until he had a recurrence. On two occasions he was opened, redrained and reconstruction done, but finally he succumbed at the end of three years to a typical cholangitis liver death.

CALEB HOWARD SMITH (Bradford, Pa.): I had a personal case of rupture of the gallbladder in a young man about seven years ago. I performed a cholecystotomy because I believed suture of the gallbladder would not be reliable, and biliary peritonitis made cholecystectomy somewhat dangerous. This patient had gone a week following his rupture and then came to the hospital intoxicated. The patient did very well and follow-up studies two years later indicated he had a good result.

A second case I would like to mention is that of a rupture of the small intestine due to blunt trauma. In a recent case a rupture of the ileum was sutured over within six hours because the patient had an obvious peritonitis. There were several other areas, as much as a foot away, which were definitely bruised and a danger of slough postoperatively was imminent. A Miller-Abbott tube had been placed in this patient before operation, and following operation the tip of the tube proceeded into the ileum. I believe this may have afforded the patient some protection against a secondary slough.

LAURIE H. MCKIM (Montreal, Canada): I wish to emphasize the point that has been emphasized by Dr. Bosworth, namely, the question of persistent pain.

I wish to tell you a story of an accident that happened where there was more than one injury. I do not think this point has been stressed by either of the authors. A Joekey of about twenty-three years of age was injured by a severe fall at about 4 P.M. and was brought to the hospital. We could not get very much history as to just what happened. The horse fell and rolled over on the patient and he was brought to the hospital in most profound shock.

Examination showed very little in the line of external trauma except a small bruise in the upper left quadrant. The man was obviously suffering from shock and the blood examination revealed there had also been considerable blood loss. He was x-rayed and there was no gas shadow.

About three hours later he was operated upon. On account of the persistent pain and the bruise in the upper left quadrant, he was explored through a left abdominal incision in the upper half. Examination showed a perfectly huge hematoma with the omentum torn almost entirely across and bleeding freely. This was controlled and the vessels tied. The tear in the omentum was so severe that the lower part of the omentum was removed. It was believed that that was quite

sufficient to account for his symptoms. Therefore, the abdomen was closed and he was given 500 cc. of blood.

He continued to complain of severe abdominal pain after he recovered from the anesthetic and died about twenty hours after injury. The post-mortem examination revealed a complete tear of the small intestine about 4 feet above the ileocecal valve. The remarkable fact was that although the man had a rapidly spreading streptococcal peritonitis, there was practically no soiling of the abdomen.

I present this as one of the cases in which there may be more than one injury, and in which hemorrhage may confuse the operator and cause him to miss a second lesion.

CHARLES HUGH MAGUIRE (Louisville, Ky.): I was interested in Dr. Newell's paper because we had one of these so-called traumatic cholecystectomies several years ago. This was a young man about thirty years of age who was thrown from the back seat of an automobile against the back of the front seat. At the time of admission he was not in any particularly serious condition; however, he complained of continuous abdominal pain which I considered to be a sign of utmost importance.

After about four hours he was explored and upon entering the abdominal cavity about 500 cc. of blood-tinged fluid was encountered. No definite injury to any of the major viscera was found; but on aspirating the cul-de-sac, an intact gallbladder appeared hanging to the end of the suction tip. Exploration of the upper abdomen revealed as clean a cholecystectomy bed as you would desire in an elective procedure.

The cystic duct and cystic artery were standing up nice and clean. There was a little bile draining from the cystic duct and the cystic artery was thrombosed. Ligatures were placed around both of these structures and the abdomen closed. The patient made a very uneventful recovery.

One other thing of importance is our present day use of contact clotting mechanisms in the form of gelfoam and oxidized cellulose. These contact clotting agents have given us a very useful adjunct in the treatment of these lacerations.

ROSCOE C. WEBB (Minneapolis, Minn.): For the sake of the record I would like to mention briefly a rupture of a bile duct. The patient was a thirty year old truck driver who had been in an accident. I saw him two weeks after the injury when it was thought he had a ruptured diaphragm. His chest had been aspirated and bile had been obtained, mixed with fluid, apparently because the needle had gone through the diaphragm.

I put in the trocar and cannular catheter to aspirate, with a mechanical suction apparatus. My catheter went in about 12 or 14 inches and an x-ray later showed that the catheter went down



midline in the region of the lower attachments of the diaphragm.

I got out a huge quantity of pure bile. I kept this up with mechanical suction for several days and the patient recovered. The fact that he had pure bile with no blood mixed with it and the fact that he recovered rather pointed against it being a rupture of the common duct or a rupture of the gallbladder, and it was all superdiaphragmatic; but the treatment of aspirating the subphrenic space worked.

I would agree with Dr. Bosworth on the difficulty of diagnosing ruptures of the small intestine. I recall three cases. The first patient, a young boy, was kicked by a horse in New York and was taken to the hospital and then sent home. He was brought to the hospital where I was house surgeon twenty-four hours later, with an obvious peritonitis. He was operated upon and recovered.

A second case occurred in Montana. The patient was hit by a revolving wrench fastened to a machine, which let go and hit the man in the lower abdomen. He was brought to me about three weeks later. He had a massive abdomen with obstruction. I operated and found he had perforation of the small intestine in the region of the lower lumbar vertebra. This patient was an example of one who had had a rupture of the small intestine and who recovered.

A third case was that of a man who was injured

at 8:15 A.M. This is comparable to the "cheese" patient. He had a pail against his abdomen and somehow or other it twisted in his clothes and pushed against his lumbar spine. He had some pain but kept on working. He worked until 12 o'clock and then went home. He was seen by a doctor at 2 P.M. when he was thought to have a perforated duodenal ulcer. He was operated upon ten hours later and recovered.

BOARDMAN M. BOSWORTH (closing): I continue to be amazed from time to time at the modesty of doctors in general, and of surgeons specifically. This morning in the discussion you have heard many cases reported. I lost track of them. Why did not these doctors publish those cases in the literature? If they had, I would have had a much better paper to present myself.

I would like to mention the use of omentum. As you all know, it is a very useful thing in a laceration of the liver to tie a tag of omentum in with your sutures if the hemorrhage is not too great.

We have used the diagnostic tap of the abdomen when any peritoneal injury was suspected from time to time at City Hospital in New York City. Our results were not all we had hoped for. Therefore, we have discontinued its use. If we believe the tap is justified, we believe that an exploratory incision is justified and will give us a great deal more positive information.



# RÔLE OF CHEMOTHERAPY IN WOUNDS AND SURGICAL INFECTIONS\*

## A STUDY OF THE SIGNIFICANCE OF GRAM-NEGATIVE PATHOGENS IN FRESH TRAUMA AND CHRONIC INFECTIONS

DOUGLAS ACKMAN, M.D. AND FREDERICK SMITH, M.B. (LOND.)

*Montreal, Canada*

IN a previous article<sup>3</sup> the authors dealt with the significance of contamination of fresh wounds and of pre-existing infections with certain pathogens and particularly with gram-positive pyogenic bacteria. About 500 clinical cases occurring over a four-year period were studied. These were analyzed and certain observations and deductions made. In particular, the rôle of local and systemic chemotherapy was discussed. A similar study dealing with the significance of gram-negative pathogens in fresh trauma and pre-existing infections is now presented. This report covers the clinical and bacteriologic studies in fifty-four patients from the surgical wards of The Montreal General Hospital. The small proportion of these gram-negative cases<sup>54</sup> out of a total of over 500 cases in the whole series is a point we believe worth emphasizing. This fact made it desirable to delay our report to allow for the accumulation of a representative, although still small, series.

The details of the technic of surgical management and method of bacteriologic sampling have been described previously.<sup>3,9</sup> At the risk of repetition these are briefly reiterated: They involved taking bacteriologic samples from wounds at operation and dressing changes as well as through "lucite" windows incorporated in a standardized form of occlusive compression dressing. This last was made necessary since dressings were invariably infrequently changed, not less than a week and often over a two weeks' period of time. We considered that more frequent bacteriologic sampling was desirable and this was done as often as twice weekly on the average.

To facilitate the studies a standard method of surgical management was adopted which observes the best known and approved surgical principles. It is flexible enough to be adaptable to all forms of trauma and infection

which might be encountered. It has already been described in the literature and it will suffice merely to enumerate the principles of the technic:

1. Delay of surgery until shock and hemorrhage are adequately controlled.

2. Surgical asepsis.

3. Preparatory washing with soap and water and copious saline lavage.

4. Appropriate timing of initial and subsequent surgical procedures.

5. Adequate surgery—initial and subsequent—including (1) excision of wound or infection—minimal, partial, maximal, often inadequately referred to as débridement; burn blisters were opened and débris was generally removed; (2) incision and counter-incision of wound or infection for relief and prevention of tension and for drainage; (3) wound drainage by oily pack, referred to as "curtain drainage"; (4) suturing: primary suture reserved for chest, head, face, joint, nerve and tendon cases; delayed primary is the general practice except in special cases. This is possible at any time during the first three weeks with revision of the wound; secondary suture at a later date, implying wound revision because of organizing granulation tissue. All suturing is done loosely to prevent tension, with its inevitable risk of edema and danger of local bacterial multiplication. Primary, delayed primary and secondary split-skin grafting are terms employed with the same significance as applied to suturing.

6. Bacteriostasis: From the foregoing it will be seen that natural bacteriostasis is given full play. It is supplemented by bacteriostatics as innocuous as possible to the reacting tissue, free or fixed.

7. Compression: Immobilization by massive occlusive compression dressings of the whole

\* This work was carried out under the auspices of the National Research Council of Canada.



FIG. 1. Case 3. A, 30 per cent burn at eighteen days heavily contaminated with *Pseudomonas pyocyanea* (blue pus). Granulations removed and delayed primary split-skin grafting of about half of area; further grafting at thirty and forty-two days without loss of graft. B, same case at forty-two day grafting, dressed to receive a few final skin patches. All were successful despite persistence of "blue pus" throughout.

part. The large bulk of cotton waste gives uniformly distributed elastic compression and drainage. By this means the vascular circulation is not impeded and is probably facilitated. Lymph stasis and edema are minimized while in surface wounds and burns plasma loss by wound oozing is lessened. Moreover, the normal mechanism controlling capillary oozing is assisted. Light plaster encasement is added at times for additional immobilization as in compound fractures of long bones. Internal fixation is done when necessary.

8. Timed infrequent change of dressings: Prevention of secondary infection is the main reason for infrequent dressing changes. This should mean not less than weekly and more often longer, while in long bone fractures much longer intervals are required to allow for callus formation. Dressings should not be removed for observation purposes. They should be removed only for definite reasons: to wit, for planned surgery because the wound is healed,

or in the very rare occurrence of adverse signs and symptoms.

9. Topical therapy: For bacteriologic observation and investigation three materials were used in an oily base for packing purposes as follows:

1. A 5 per cent emulsion of sulfathiazole was employed in most of the cases because of our experience with its successful elimination of the pyogenic streptococcus, always a menace initially or as a subsequent contaminant. It has no influence upon the presence of gram-negative pathogens.

Sulfathiazole Emulsion (M.G.H. Formula)	
	Per Cent
Sulfathiazole.....	5
Triethanolamine.....	2
Distilled water.....	24
White beeswax.....	5
Liquid paraffin.....	64

2. A penicillin cream (1,500 units per Gm.) was used in a number of patients who were known to have staphylococci contamination. This showed no effect upon gram-negative pathogens. Additionally, it did not tend to eliminate the pyogenic staphylococcus.

Penicillin Cream (N.R.C. Formula)	
(1,500 Units per Gm.)	
	Per Cent
Z 2 Stearic acid.....	15
Lanolin.....	8
Mineral oil.....	25
Water to.....	100
Carbitol.....	5

3. A streptomycin cream (10,000 units per Gm.) was employed in four pre-existing infections (chronic leg ulcers) two each infected with *Pseudomonas pyocyanea* and *Bacillus proteus vulgaris*. It had no effect upon these organisms. It was noted, however, that they regularly and rapidly (in a few days) become streptomycin-fast.

Streptomycin Cream	
(10,000 Units Per Gm.)	
	Per Cent
Stearic acid.....	10
Cetyl alcohol.....	5
Spermaceti.....	8
Lanolin.....	15
Water to.....	100
Glycerine.....	10

*Fresh Trauma—Twenty-six Clinical Cases.*  
*Pseudomonas pyocyanea* was a contaminant in

*American Journal of Surgery*



FIG. 2. Case 25. A and B, 60 per cent deep and superficial burn showing state of slough heavily contaminated with *Pseudomonas pyocyanea* and *Bacillus proteus*, eighteen days after admission. C, three months after admission; healing is complete although both organisms persisted throughout seven skin grafting operations at nine-day intervals.

twelve of these and persisted in nine until healing was complete. Of these twelve clinical cases, three were delayed primary sutured wounds and seven delayed primary split skin grafts. *In not a single instance was primary healing delayed*, despite persistent organisms. Cases 3 and 25 are perhaps particularly noteworthy. These were 30 and 55 per cent burns and had successive split-skin grafting at nine to 10 day intervals, starting at the end of the third week, and the grafting was done in the face of heavy contamination with *Pseudomonas pyocyanea*, *Bacillus proteus* and *Pseudomonas pyocyanea*, without interference with healing. On the contrary, it was entirely suc-

cessful and we have had many other similar experiences. (Figs. 1 and 2.)

There were thirteen contaminations with *proteus vulgaris* and the organism persisted until healing in most instances. Despite this, eleven of these cases including five skin grafts had uninterrupted primary healing. In three cases, 11, 12 and 20, there was some delay and/or loss of skin graft. The delay in each instance could be explained on the basis of constant recontamination of ineffectually dressed wounds of buttock and thigh.

Every surgeon will bear witness to the practical impossibility of preventing recontamination of such wounds. Their dressing problem

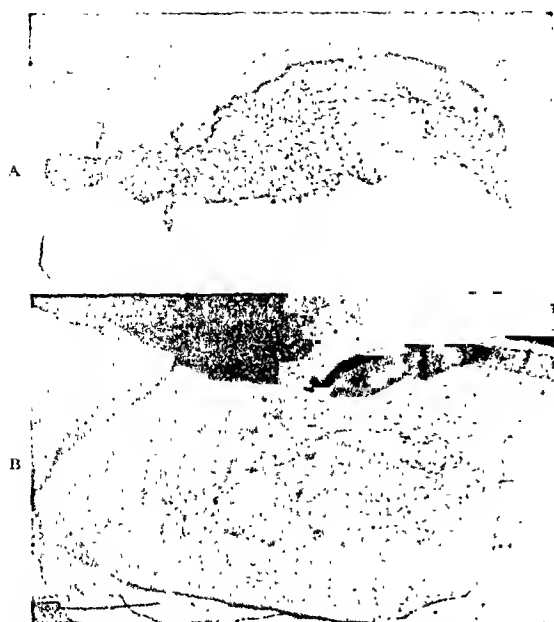


FIG. 3. Case 26. A, revision of thigh amputated at twenty-one days with delayed primary split-skin grafting and suture; *Bacillus proteus* pus present; note healthy granulations removed as usual for grafting bed. B, same case at forty days showing complete healing despite persistence of *Bacillus proteus* to healing.

is perhaps best settled by appropriate posture, exposure to the air and adequate nursing; although sometimes as with skin grafting, it is both necessary and desirable to produce clinical obstipation for several days while using an occlusive compression dressing.

*Escherichia coli* and coliforms were cultured in six cases, but in no instance presented any clinical problem whether alone or co-existent with other organisms.

*Clostridium Welchii* co-existed in three instances as a contaminant but disappeared before healing and without infecting. (Figs. 3 and 4.)

*Pre-existing Infections with Gram-negative Pathogens—Twenty-eight Cases.* In thirteen cases of chronic infection with *Pseudomonas pyocyanea*, surgical revision and delayed primary suture or split skin graft were carried out. Some delay in healing occurred in two instances. One was a delayed suture in an eighty-four year old debilitated and arteriosclerotic man (Case 3), with gross, chronic osteomyelitis of the femoral trochanter. It was impossible to do a complete sequestrectomy and he developed a persistent sinus which finally healed. The second patient (Case 13)

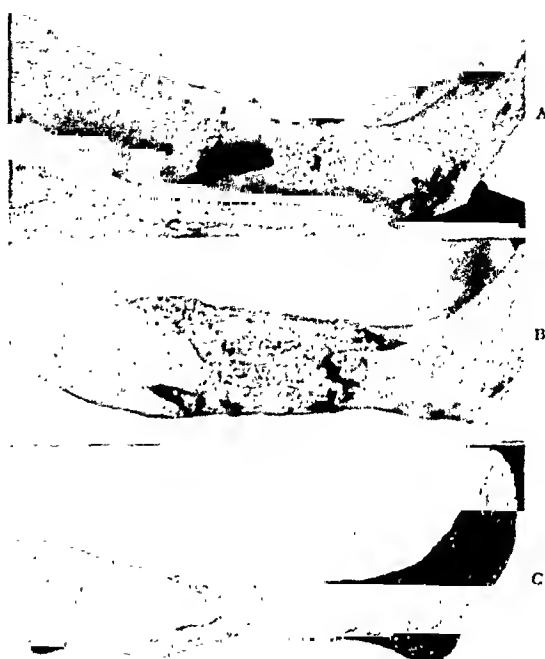


FIG. 4. Case 16. A, crushed leg with compound fracture dislocation of ankle; illustration shows extensive slough starting to demarcate at twelve days; *Bacillus proteus* present. B, same leg still heavily contaminated with *Bacillus proteus* at twenty-four days; wound was revised and grafted at this dressing. C, primary healing with persistent culture of *Bacillus proteus*.

had large bilateral chronic leg ulcers with particularly poor circulation. She was a drug addict and extremely debilitated. We were rather surprised to have successful delayed primary grafting on the one side and ultimate success with the other. (Fig. 5.)

Of fifteen chronic *Bacillus proteus* infections having surgical revision and delayed suture and skin graft, four cases (14, 17, 21 and 23) showed some delay in healing. Of these Case 14 was an old traumatic leg ulcer involving the tibia with much loss of muscle and other tissues and consequent great scarring and poor circulation. Case 17 was a vagabond in whom the circulation of the extremities was very poor but results were ultimately successful. Case 21 had several deep sinus tracts running in old scar from old femoral osteomyelitis and Case 23 actually had tuberculous tissue found on first excision and so might be excluded.

The occasional<sup>3</sup> coliform cultures occurring in conjunction with the other gram-negative organisms appeared to have no influence upon

the fate of the case or the other organisms. It should be worth recording at this point that in our whole experience with trauma and infections (over 450 cases) we have had only one instance in which coliforms appeared significant, a primary skin graft referred to in our previous report.<sup>9</sup>

*Comment.* Pyogenic staphylococcus was present in 55 per cent of the cases but was found to be without any significance even when persistent to healing. Pyogenic streptococcus occurred much less frequently and then only on initial cultures. It regularly disappeared early and we believe has no significance in these cases. In not a single instance did invasive infection develop. *Cl. Welchii* co-existed in three clinical cases with gram-negative organisms but without producing clinical disease.

Although actual invasive infection with these organisms has not been common in our series, we have met with a few of these problems. In these instances the use of streptomycin intramuscularly in 2 Gm. doses for ten-day periods has been highly successful.

M. F., a twenty-five year old nurse, entered the hospital first in 1938 with slowly developing abscesses of the subcutaneous tissue and fascia of the lower abdominal wall. These contained frank *Bacillus proteus* pus and had definite burrowing characteristics. From the first to the last, until July, 1947, this patient's history has been an almost continuous succession of similar burrowing subcutaneous and fascial abscesses over an area extending from the waistline down to the mid-thighs. During most of this time she has been in the hospital. (Fig. 6A and B.)

Radical excision of the involved areas, particularly of subcutaneous and scar tissue, with split-skin grafting seemed to check the infection locally, but new abscesses appeared in adjacent old scar areas at intervals of weeks or months. In July, 1947, she had an abscess in the scarred thigh and this contained the usual *Bacillus proteus* and also *Staphylococcus pyogenes*, unfortunately penicillin-fast. After excision she was given streptomycin intramuscularly, 2 Gm. daily for ten days, in divided doses of 0.5 Gm. The *Bacillus proteus* disappeared at once from the lesions and has never been recovered since, although she continued to have occasional staphylococcal abscesses in

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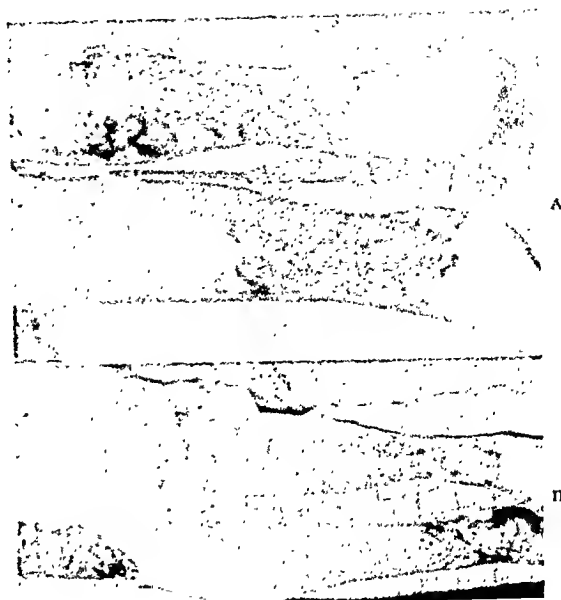


FIG. 5. Case 13. A, extensive leg ulcers of long standing with very poor circulation. The ulcers had previously been excised and now after sixteen days the granulations shown were excised again and split skin grafting done. There was a heavy growth of *Pseudomonas pyocyanea* on the left leg and of *Bacillus proteus* on the right leg. B, same case at thirty days (two weeks after grafting) showing complete take of graft on left leg and incomplete on the right leg. The patient, an uncooperative drug addict, left the hospital refusing further treatment.

the scars. Figures 6C, D and E show the histology of this patient. Six months later the patient had the old scar excised and successfully grafted primarily. The patient is now clinically well for the first time in years.

In another instance of acute invasive infection we have observed apparent synergism between streptomycin and penicillin. Pneumonia which supervened during the third week of hospitalization responded well to penicillin. However, remittent and continuous fever which developed in the fifth week did not respond to either penicillin or streptomycin alone, but dropped promptly with combined therapy of 2 Gm. of streptomycin and 300,000 units of penicillin daily.

Finally it would appear from our experience that when gram-negative pathogens actually cause clinical problems by invasion, the general or local physiologic conditions are to blame, and that surgery and antibiotics interdependently appear satisfactory answers to the problem.

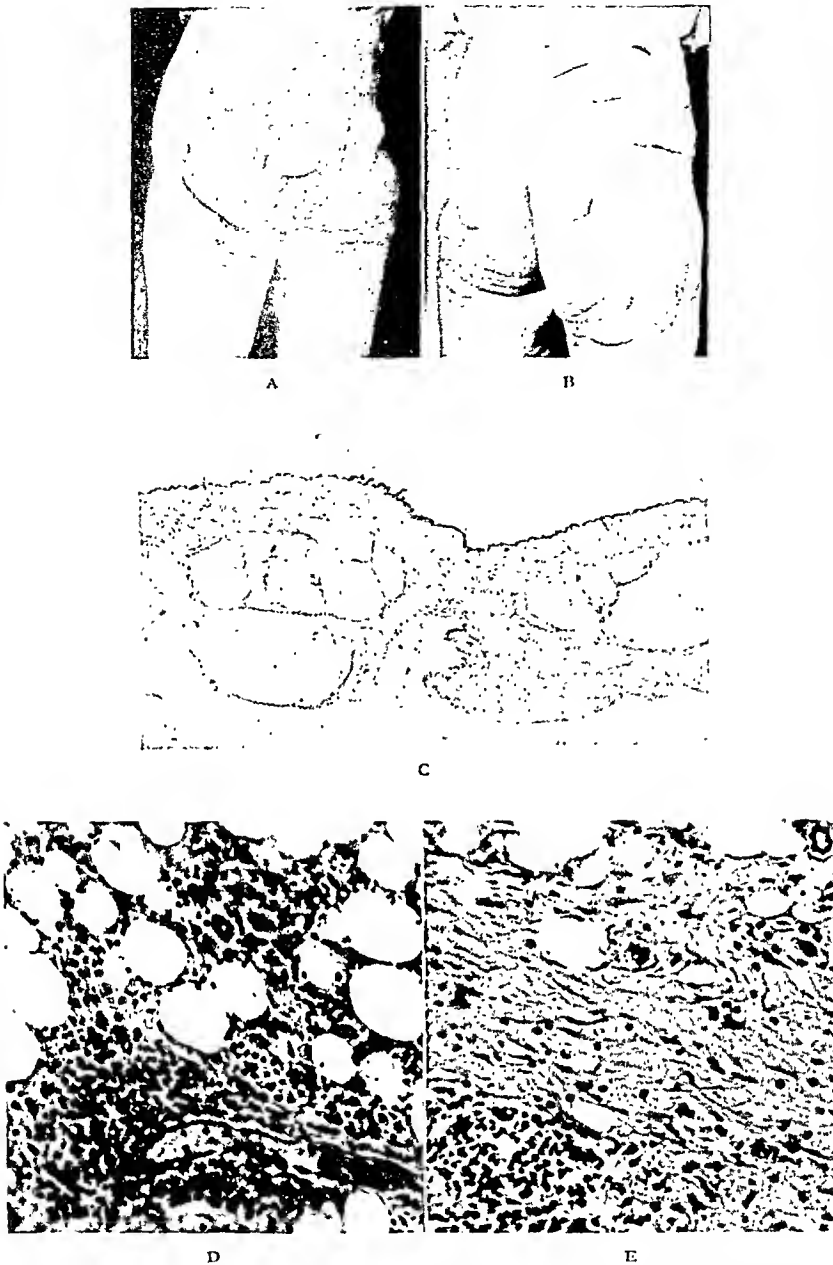


FIG. 6. A and B, results of chronic subcutaneous infection of eleven years' duration showing much loss of tissue from numerous wide excisions, scarring and skin grafting. C, low power view of section of skin and subcutaneous fat through site of previous excision. In the center of the section there is a depressed scar in the skin extending into the fat. In the subcutaneous part of the scar is the cavity of an abscess lined by granulation tissue which shows as a dark membrane heaped up on one side. D, section of subcutaneous fat showing heavy infiltration with inflammatory cells chiefly lymphocytes with fewer polymorphonuclears and large phagocytes. E, section of margin of scar in the subcutaneous tissue showing non-suppurative inflammatory exudate and fibrosis incorporating fat cells.

## SUMMARY

The foregoing study reveals the following pertinent facts:

1. Gram-negative pathogens are by no means the most frequent contaminants met with in fresh trauma (twenty-six cases in over 250) or in surgical infections (twenty-eight cases in over 300).

2. When present they are most often found in lower extremity lesions.

3. In both fresh trauma and surgical infections these organisms tend to persist even though their presence rarely causes delay in healing.

4. In fresh trauma despite their persistence, these organisms show almost no tendency toward invasive infection when sound wound management is applied and circulation is adequate. Consequently, delayed, revision surgery and skin grafting may be done with relative impunity.

5. In pre-existing surgical infections with gram-negative pathogens, revision grafting or surgery is almost equally immune when local and general physiologic conditions are satisfactory, even though contamination be gross.

6. The corollary to this statement is that adequate blood supply and all other physiologic conditions should be zealously protected in every wound or surgical infection.

7. These physiologic conditions are well maintained locally as indicated<sup>3</sup> by some form of occlusive compression dressings infrequently changed. The authors believe strongly in the rôle played by these dressings in wound healing. Maintenance of the general physiologic condition requires no comment here.

8. No evidence has been adduced clinically in trauma that symbiotic influence as between gram-negative and gram-positive pathogens exists.

9. Such bacteriostatics and antibiotics as we have used topically with the technic described, including sulfathiazole, penicillin and streptomycin in cream bases, have regularly failed to eliminate gram-negative pathogens in fifty-four cases of fresh trauma and surgical infections.

10. Streptomycin in a cream base has quickly and regularly caused "fast" organisms in four instances.

11. Contrary to these results the authors have been greatly encouraged in this work by these more recent experiences with streptomycin when used in certain gram-negative infections with specific techniques and have cited certain of these experiences.

12. When invasion by gram-negative organisms does occur, intramuscular streptomycin has given very encouraging results in the few instances so far observed.

13. We have seen an apparent synergistic effect between penicillin and streptomycin in one instance.

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# THE SIGNIFICANCE OF GRAM-NEGATIVE PATHOGENS IN RECONSTRUCTIVE SURGERY

JOHN GERRIE, M.D.

Montreal, Canada

RECONSTRUCTIVE surgery from simple split-skin grafting to complicated pedicle maneuvers is often necessary in



FIG. 1. An occlusive pressure dressing in an extensively burned patient. Children are comparatively comfortable and the dressing need only be changed every seven to ten days under anesthetic when further wound revision or skin grafting is indicated.

areas and regions heavily contaminated with gram-negative pathogens. Past teaching has indicated the presence of these organisms to be dangerous and to jeopardize the outcome of such procedures. In the light of present day wound-patient management it would seem these pathogens are merely contaminants and have little, if any, adverse effect on the result of the plastic surgery that is done.

True, this places a new aspect on those old offenders, *Pseudomonas pyocyaneus*, *Bacillus proteus* and *Bacillus coli* formerly thought to be so malignant. Yet the teachings of the late Dr. Fraser Gurd and the work of Aekman and Smith<sup>1</sup> and other collaborators at McGill and the Montreal General Hospital seems to throw them in a much less baneful light. The experiences of plastic surgeons in general and their developments of the last few years seem to confirm this line of thought. A brief survey of their methods and the surgery accomplished in the obvious presence of gram-negative pathogens should be timely.

Present surgical teaching dictates that patients will not be operated upon electively un-

less they are in a certain state. This is simply that they shall not be debilitated, their morale shall be good, that they shall not be anemic and that their blood proteins shall be at or near normal levels.

Present surgical teaching also dictates that an effort shall be made to produce a certain wound state, to bring the wound into a healing phase. This means simply that the wound shall be healthy and show early signs of healing, in other words, that the wound be in a receptive state for grafting. Occlusive pressure dressings (Fig. 1) are very helpful in placing both the patient and the wound in these desirable states. Débridement of the wound is often a very helpful short cut. Meticulous graft care and postoperative fixation need no emphasis.

With these factors in operation, gram-negative contamination will be at a minimum, and what there is will be relatively harmless to a variety of reconstructive procedures that may be carried out.

*Indolent Wounds.* Indolent wounds with exuberant granulations harbor gram-negative pathogens. Theoretically, they are not satisfactory for grafting as the secretions tend to lift up the graft. A week or ten days would be well spent in improving the wound state with occlusive pressure dressings. However, débridement may be an indicated short cut. If the patient state is good and the wound not too large and in a place where an effective postoperative dressing may be used, débridement down to a firm bleeding basis will remove the gram-negative pathogens and permit satisfactory grafting. (Fig. 2.)

*Grafting about the Mouth.* Split-skin grafting in the mouth, employing a stent technique, has always been a certain procedure, this in the face of saliva and both gram-negative and gram-positive infection. The stent just pushes the organisms out of the way and provides the requisite pressure for graft take.

On the other hand, pedicle grafting about the mouth (Fig. 3) is a more hazardous procedure

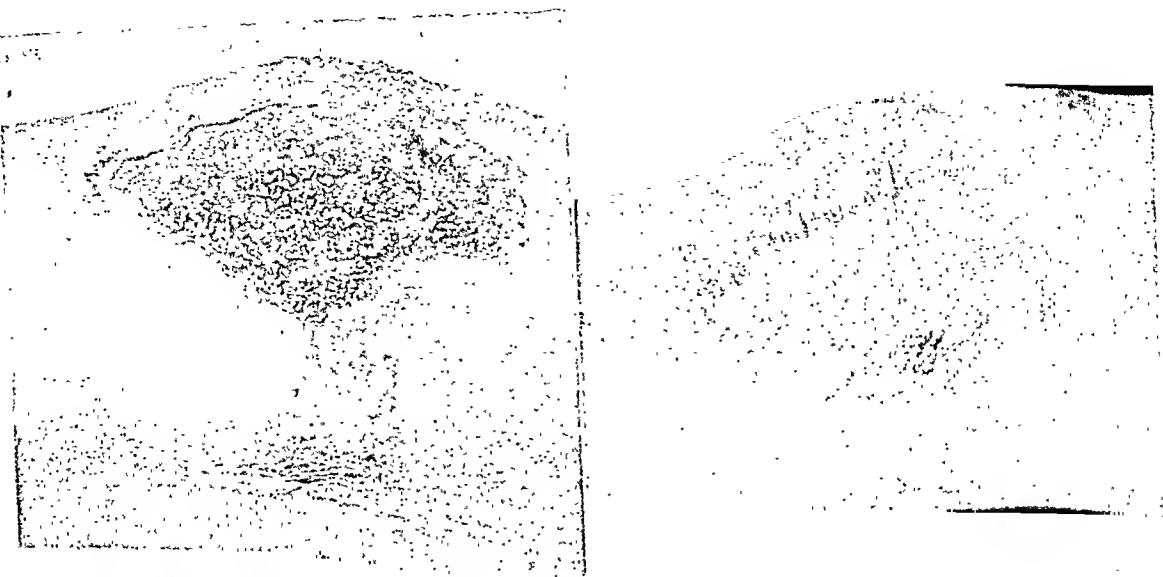


FIG. 2. A, small indolent wound suitable for débridement and grafting; B, the result.

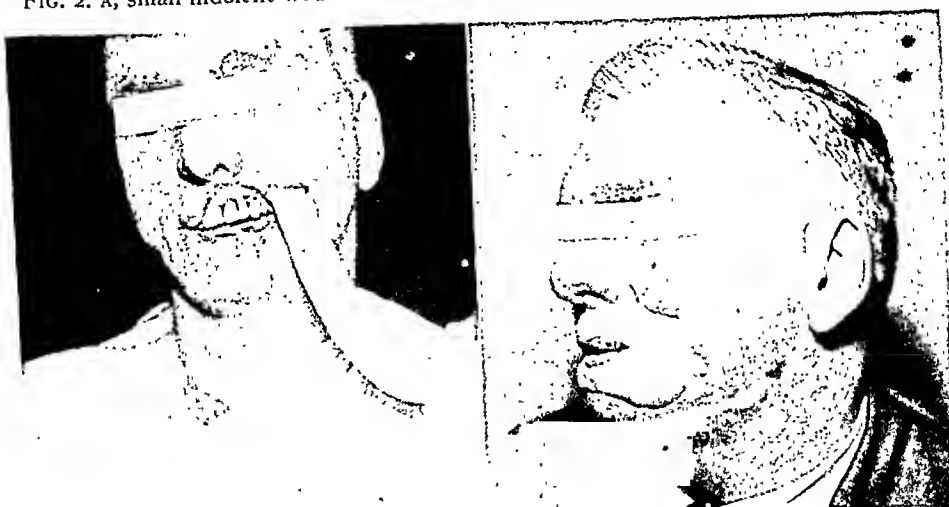


FIG. 3. A, tubed pedicle grafting to the mouth indicating the difficulties of wound control; B, grafts do take in spite of these difficulties.

because of the continuous movement, the presence of mouth infecters and the impossibility of using stent or pressure dressing. No precise control of these adverse factors is possible. Yet pedicles do take reasonably well in the face of these obstacles.

*Grafting about the Anus.* This is a region obviously contaminated with gram-negative pathogens. Yet if bowel movement is held in check for four or five days, grafting of both the split-skin variety and rotation pedicle types is fairly certain. A rather wide experience with rotation flap maneuvers to close ischial ulcers in paraplegic patients has proved this conclusively.

*Grafting in Extensive Burns.* In the extensively burned patient all factors seem to be working against the successful grafting of the patient. Debilitation sets in, morale deteriorates, anemia and hypoproteinemia are hard to control and the wounds become indolent and loaded with gram-negative pathogens. (Fig. 4.) The patient's debilitation and anemia will permit little or no débridement. Yet by vigorous pursuit of all these adversities, grafts do take or take in part. The gram-negative pathogens are pushed aside, the patient's condition improves with each grafting and the burn wounds are eventually healed. Langhor, Owen and Cope<sup>2</sup> have recently pointed out the frequency

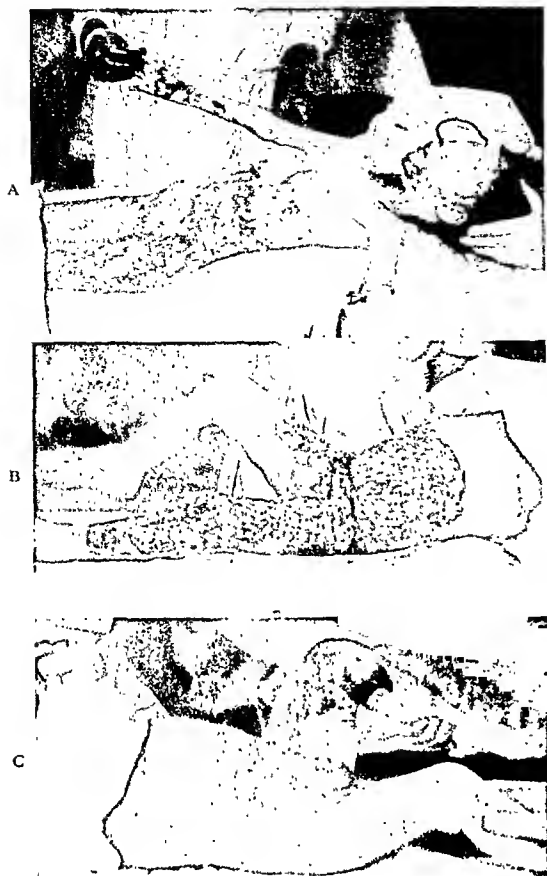


FIG. 4. A, an extensively burned patient showing obvious debilitation anemia, hypoproteinemia, wound indolence and contamination. B, an extensively burned patient in whom debilitation and anemia have not yet become apparent. The wound is contaminated with *B. coli* and *proteus*. C, the same patient as in B three weeks later showing autografts on the abdomen and beginning dissolution of homografts on the leg. (Negative has been reversed in printing.)

of infection with gram negative pathogens of burn wounds of the trunk, buttock and lower extremities.

**Decubitus Ulcers.** The results produced in many centers in the grafting of decubitus ulcer sites of paraplegic patients should put the final quietus on this gram-negative bugaboo. These ulcers are principally in the sacral, ischial and trochanteric regions and, therefore, in spite of careful dressing technics are invariably contaminated with *Bacillus coli* and *Bacillus proteus*. In a recent article, Gerrie and McNeil<sup>3</sup> have admitted an early invasive phase in the production of the decubiti when both gram-positive and gram-negative infecters carry on

invasive and destructive activity. However, given this same patient with two to three weeks' care in a paraplegic center, with attention to patient and wound care, the ulcer can be brought to a healing phase when it is ready for any reconstructive procedures (Fig. 5) and the gram-negative pathogens have little if any hindrant effect.

**Bone Cavities of Chronic Osteomyelitis.** One of the interesting contributions of war surgery has been the combined orthopedic and plastic approach to the treatment of infected bone cavities. The work of Shannon and Woolhouse<sup>4</sup> at the Queen Mary Veteran's and Montreal General Hospitals has been one of these contributions. Their cases have been mostly of the traumatic, exogenous type of osteomyelitis with a mixed infective factor, gram-negative pathogens being commonly present. Fifteen years ago it was taught that you could not skin graft on bone. Now the bone and adjacent tissues are débrided widely, the infection cut out and the bare bone is skin grafted with a gratifying percentage of take. (Fig. 6.) The osteomyelitis is cured and subsequent cross-leg or other types of pedicle grafting fill out the contour of the leg at a later date.

**Grafting Mastoid Bone Cavities.** The grafting of an infected mastoid cavity following radical mastoidectomy is a somewhat similar procedure that has been done for years. This cavity often contains both *Bacillus coli* and *Bacillus proteus* as well as other stringy, mucus producing gram-negative contaminants from the mouth and yet grafting here meets with a fair measure of success.

**Reconstruction of the Urethra and External Genitalia.** Reconstruction of the congenitally absent vagina entails split-skin grafting of a large cavity created between the rectum and the bladder. McIndoe and Banister<sup>5</sup> have done this using a vulcanite mould. Owens<sup>6</sup> prefers a pyrex form while Adams<sup>7</sup> uses ordinary rubber sponge cut to the desired shape and size to carry the skin graft into position. These men have shown excellent results with complete skin graft take in areas obviously contaminated with gram-negative pathogens.

Resurfacing of the penis from which the skin has been lost because of accident or infection is not an uncommon procedure. The work of Brown<sup>8</sup> and Byars,<sup>9</sup> using a careful graft and dressing technic, has produced some startling results.

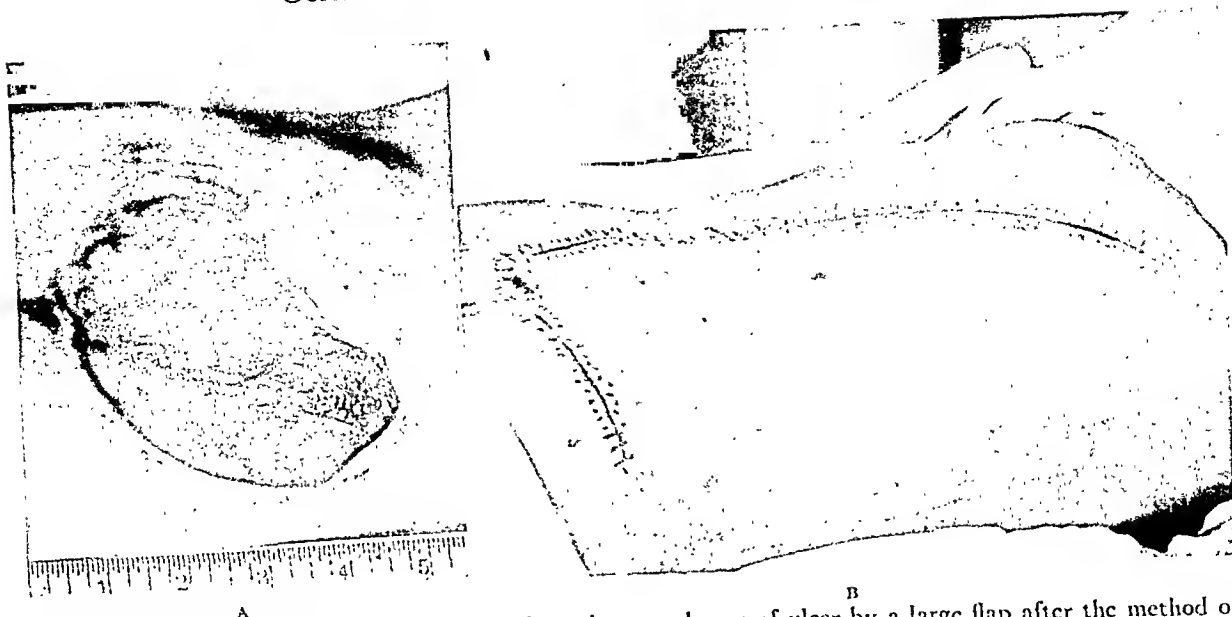


FIG. 5. A, sacral decubitus ulcer in a paraplegic patient. B, closure of ulcer by a large flap after the method of Blascovic.

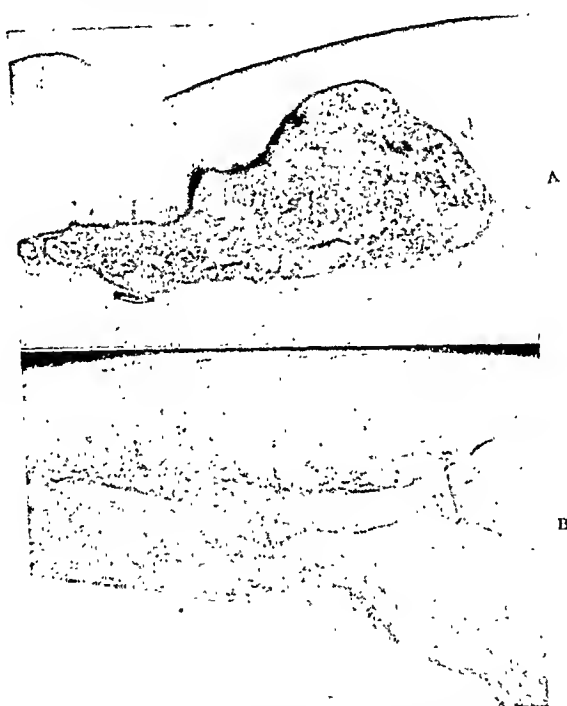


FIG. 6. A, an osteomyelitic wound of the femur. B, the same wound split-skin grafted before final revision.

Grafting of the male urethra both for congenital hypospadias and traumatic stricture is another common procedure. McIndoe<sup>10</sup> has popularized the inlay skin graft type of reconstruction and Young<sup>11</sup> has carried this to a further stage of perfection. Recently Gerrie and MacLean<sup>12</sup> have reported on the skin grafting of the bulbomembranous urethra in traumatic war cases.

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The aforementioned reconstructive procedures carried out in areas contaminated with gram-negative infection would indicate a new assessment of the surgical significance of these pathogens.

#### CONCLUSIONS

1. Reconstructive procedures are commonly carried out in areas heavily contaminated with gram-negative pathogens.

2. With acceptance of present day conceptions of patient care with the correction of morale, anemia and hypoproteinemia, and with attention to wound detail of occlusive pressure dressing, débridement, graft fixation, etc., the gram-negative pathogens seem to be contaminants rather than infecters and have little or no adverse effect on reconstructive procedures.

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## DISCUSSION OF PAPERS BY DRs. ACKMAN AND SMITH AND GERRIE

LAURIE H. McKIM (Montreal, Canada): The important thing appears to be that these men have done this work with a great deal of care. You will notice that Dr. Ackman said the bacteriology was done by one technician; the technic was the same for all cases. I do not think there is much chance for a slip of any kind in the bacteriology technic. We have been impressed with two or three things:

Those of us who are not doing this work ourselves believe that the success they have obtained is due largely to the infrequent compressive dressings. They keep the wound covered up. They dress wounds very infrequently and with very great care, controlling all cases by careful cultures. They have a very ingenious device for taking cultures

through a little plastic window which they have placed in the dressing.

The two points we have been impressed with are, first, that the infections are controlled mainly because they keep them under continuous pressure dressings; secondly, when the thing is analyzed it would seem that under these circumstances the gram-negative bacteria are no great deterrent to grafting or to the revision procedure, and are probably of much less importance than they were thought to be.

There is just one point that Dr. Ackman did not mention. He has a very strong suspicion that in some cases there may be a synergistic action between penicillin and streptomycin. In one or two cases in which neither of these bacteriostatics were of any use whatsoever, they seemed to do something when combined.

HARRY HOYLE CAMPBELL (Toronto, Canada): I would like to point out that a properly prepared bed can usually be obtained in these ulcers. The use of the saline baths during the war led us to believe that while infrequent dressings were important early, when there was gross contamination with *Bacillus proteus* or *Bacillus pyocyaneus*, one could clean up the wounds very well with saline baths. While the ulcers would clean up clinically quite remarkably, cultures might still grow gram-negative and gram-positive pathogens.

However, grafting in the presence of gross infection is mainly a technical problem as the graft is floated off the bed by the exudates. This can be controlled in many ways, one, simply by putting the graft under tension when it is sewn down, because there is a lot of edema in the part anyway. When the patient is very ill and it seems imperative to cover the large ulcers fairly early, dressings of the wound may be done after twenty-four and forty-eight hours to open any small abscesses that occur under the graft. This prevents further floating of the graft from the bed and large grafts can thus be saved.

It may be difficult to do a dressing where gross contamination is present. Pararesined gauze mesh can be sutured over the top of the graft when it is applied under fair tension. Later if one wants to open a small abscess in the bed of the graft, it is merely necessary to soak off the top dressing and the graft is not lifted from its blood supply. Dressing these contaminated grafted patients early prevents much of the maceration and breaking down around the edges of the graft. The saline bath is of great help here.

One believes that all raw areas should be covered at the initial operation if possible with free skin grafts and, if necessary, to rotate flaps over the defects. This prevents a lot of wound infection in the postoperative period and shortens the patient's disability considerably.

As far as the exposed bone cavities are concerned, the use of free skin grafts in them has been a great help. We have moved flaps over bone cavities early and in some cases have inserted cancellous bone chips at that time. These were done more or less for investigation, and it was quite remarkable how well healing took place without difficulty by covering with a flap, cleaning out the cavity and putting in cancellous bone chips.

I do think it is safer, however, to graft the cavity first and clean up all the infection. A flap covering may then be applied later and the cavity filled with cancellous bone chips. In the jaw or places with good blood supply one can do the other procedure in selected cases and save the patient one stage.

DONALD M. GLOVER (Cleveland, Ohio): The speakers have called attention to the fact that these organisms are primarily of nuisance value. I think that is essentially true. However, it is a fact that pyocyaneus infection particularly may interfere with the perfection of the skin graft, especially around the margins.

We had a rather long, concentrated course in these organisms when operating a general hospital in New Guinea, where, because of the constant moisture of the skin, these contaminants were almost universally present on the skin and in wounds also. Of course, the organisms do not grow in a dry field, so as long as the dressing is completely dry these organisms practically will not grow.

I think it is worth mentioning that these infections are completely controlled by an effective hypochlorite solution dressing. In fact we used the presence of any green stain as evidence that our Dakin's dressings were not being properly applied.

We usually found that, particularly while working in the tropics, if we continued Dakin's dressings directly over the graft after twenty-four hours and

kept them wet with Dakin's solution, these minor contaminants were completely eliminated and the perfection of the graft was maintained. If the dressing can be kept completely dry throughout, however, it is not necessary to use Dakin's solution.

R. ARNOLD GRISWOLD (Louisville, Ky.): A great many of us, since the days of sulfas and penicillin, have been impressed by the fact that our gram-negative infections got along better even though we know that these drugs do not act predominately on gram-negative organisms. That is one point which has been brought out, but I should like to sound a warning to those of you who do not have as careful bacteriologic control as Drs. Gerrie and Ackman.

If you take a primary smear from a contaminated wound or from an appendiceal abscess, you will find it loaded with gram-positive as well as gram-negative organisms. However, if it is cultured on ordinary laboratory culture media by an ordinary hospital technician, you will get a bacteriologic report of colon bacillus or proteus or pyocyaneus. The reason for this is that the gram-positive organisms have been overgrown in the culture media by the gram-negative organisms. Unless you control the gram-positive organisms in the wound, you are going to have invasive infection even though the bacteriologic report mentions gram-negative organisms.

The bacteriology which has been done on the cases reported this morning has been very careful, and they knew what organisms they were dealing with; but in the ordinary hospital laboratory bacteriologic report we do not know accurately what organisms we are dealing with, and a report of gram-negative bacteria simply means that the harmless gram-negative pathogens (if you wish to call them that) have overgrown the harmful gram-positive pathogens in the culture media.



# LATE JOINT CHANGES AS A RESULT OF INTERNAL DERANGEMENTS OF THE KNEE\*

RALPH K. GHORMLEY, M.D.

*Rochester, Minnesota*

**A**N important reason for correction of internal derangement of the knee joints not frequently enough stressed is the late changes that follow the initial damage. Such changes may be obscure or relatively undeveloped at the time when the derangement is first recognized and treated. These late changes at times are much more important than the immediate disabling defects. In order to understand these changes it is necessary to point out (1) the vulnerability of articular cartilage to trauma, (2) the relatively poor power of the cartilage on the articular surface of a joint to repair itself and (3) the inevitable result of the two preceding facts, that is, an irreparable damage which often is present after existence of an internal derangement for any considerable period.

By internal derangements is meant almost any condition affecting the articular surfaces or stability of the knee, whether it be by trauma, by disease or by neoplasm. Any loose or partially detached body which may impinge on the articular surfaces or be caught between any of the articular surfaces of the joint leaves its toll of damage to those surfaces. If the locking is between weight-bearing surfaces during the act of weight-bearing or between joint surfaces during action of muscles or movement, the damage is that much more severe. Then, too, if the loose body is firm and hard, more damage is done than by a soft cartilaginous structure like a meniscus.

Once a joint surface has become damaged or roughened its contiguous surface becomes subject to erosion during motion by the roughened area opposite it and wear and tear begins. One often sees direct evidence of this in joints opened for exploration and treatment of various sorts of internal derangement. I have been particularly interested in these observations. In order to record them more accurately, I frequently asked our photographic department to take colored photographs of knee joints

opened at operation.\* These pictures show the damage which may be inflicted on the joint surfaces of the knee by various types of internal derangement.

These changes are insidious in onset and slow in development so that it may take years for any serious demonstrable changes to come to light or to develop to the point at which they may produce symptoms. Patients may hesitate to see a physician because of the mildness of the symptoms produced. Likewise, the physician may be inclined to minimize the patient's complaint and unless he carries out a very careful examination he may miss some important diagnostic points. Beside a routine physical examination of the knee, with careful check for traces of swelling, effusion, atrophy, instability, tenderness and deformity, roentgenograms of several types should be made. These should include anteroposterior and lateral roentgenograms carefully taken as to position of the knee and direction of the rays, intercondylar notch roentgenograms made with the knee in flexion and the rays projected through the intercondylar notch and special patellar roentgenograms to demonstrate the contours of the patellofemoral joint and the relation of its surfaces. By these many irregularities of joint surface contours and relationships may be detected.

## VARIOUS CONDITIONS WHICH CAUSE CHANGES

*Torn Menisci.* Late changes following this type of injury are of two kinds: those changes due to damage to the articular surfaces from the repeated lockings before surgical removal of the menisci and those changes secondary to removal of the menisci. Some have written of the latter changes and pointed out their occurrence but in my experience such changes are rarely as marked as the changes might have

\* Dr. Ghormley showed colored pictures at this point which are not included in this publication.

\* From the Section on Orthopedic Surgery, Mayo Clinic, Rochester, Minn.

been had no semilunar cartilage been removed when it was indicated. In most instances a minute degree of thinning of the joint space on the side of the affected cartilage will be noted. In my experience this is of little importance if the damaging element has been removed, but if the damaging element is allowed to remain in the knee for a long enough time, serious changes do take place. Or if complete removal of that portion of a cartilage which is locking is carried out, further damage may be rendered to the joint surface.

Cysts of semilunar cartilages may also be the cause of lasting damage to the joint surface. In their early stage of formation while still small cysts they cause very little change, but as they become enlarged and encroach on the joint space some erosion of the articular surfaces occurs. This is variable in amount and is directly proportional to the size of the cyst and to its disturbance of the joint surface relationships.

*Osteochondritis Dissecans.* Osteochondritis dissecans has long been recognized as a cause of internal derangement of joints, particularly the knee joint. The amount of damage in such a joint depends on whether the segment of bone and cartilage has become loose in the joint and on the duration of time over which lockings have been repeated. The joint surface may be fairly intact in early cases, particularly if the patient is adolescent. In these cases a minimal amount of erosion takes place. As the fragment leaves its bed and migrates through the joint the erosion continues as the result of two factors: (1) the loose body itself locking and damaging the articular surfaces with each locking and (2) the erosion due to the irregularity of the joint surface at the site of origin of the loose body. If locking goes on over many years, fairly extensive damage to the articular surfaces will take place—damage which is irreparable by any method now known.

*Synovial Chondromatosis.* Synovial chondromatosis is another cause for the formation of loose bodies within joints. The cause of this complication is presumed to be a metaplasia of the synovial membrane and particularly of that portion of it bordering on the articular surfaces of the joint into a benign type of neoplastic tissue. The loose bodies vary in size from tiny cartilaginous bodies to large bodies, 1 to 2 cm. in diameter, composed of cartilage and bone. Frequent lockings are often noted

and in these cases repeated damage to the articular surface occurs.

*Chondromalacia of the Patella.* This condition has fairly recently come into the category of recognized clinical entities. According to Cox, the condition was first described by Büdinger in 1908. Cox also described the gross pathologic changes noted at operation as follows: "(1) Softening, irregularity in contour and fissure formation in the articular cartilage of the patella; (2) yellowish discoloration of the articular cartilage of the femoral condyle on the anteromedial aspect; (3) similar changes in the articular cartilage of the femoral condyle on its anteromedial aspect; (4) thickening, hyperaemia, and villous degeneration of the synovium, usually confined to the suprapatellar pouch region and anterior compartment of the knee joint; (5) increase in the amount of joint fluid, usually clear yellow in color with normal cell count, or slight increase in polymorphonuclear cells; (6) pannus formation at the edges of the articular cartilage of the patella and femoral condyles."

All degrees of destruction of the articular cartilage of the patella have been noted. In milder cases pain is minimal and is noted on flexion of the knee and particularly on extension of the knee as in the act of stair climbing. In more advanced cases symptoms suggestive of locking are noted as the patella glides across the roughened femoral surface of the patello-femoral joint or as marginal spurs on these two surfaces impinge on each other. In more advanced cases patellectomy is indicated. In milder cases the roughened surface of the patella may be smoothed off with some improvement in the symptoms.

This condition is often seen as a complication in cases of recurring dislocation of the patella. In older cases the changes often reach an advanced stage with almost complete destruction of the articular surfaces of the patello-femoral joint.

*Synovitis of the Knee.* Several types of synovitis of the knee joint are now recognized, such as: Traumatic, acute, with or without hemarthrosis; chronic, as a complication of traumatic arthritis; infectious, due to various types of infecting micro-organisms such as tuberculosis, brucellosis and so forth; rheumatoid, intermittent hyarthrosis; secondary to tumors as xanthomas, hemangiomas and synoviomias, and hemophilic.



Any of these types of synovitis may leave some damage to the joint surface. While it often is minimal in more prolonged cases, the damage may be severe enough to produce changes in the articular surfaces which will lead to permanent defects in the joint surface and to traumatic arthritis.

*Fractures.* Various fractures about the knee joint are a frequent source of damage to the articular surfaces which may become potentially symptomatic.

Fractures of the patella, fractures of the spine of the tibia and fractures of the tibial plateau are all intra-articular and may leave irregularities which can produce symptoms later on in life. The long-continued wear and tear on a knee joint in a leg in which bowleg or knock knee has been caused by a fracture will lead to traumatic arthritis in a large number of cases.

In these cases not only is there a direct trauma to the articular cartilage at the time of the injury but the stresses and strains on the joint surface due to abnormally directed forces in the malposed joint produce further changes. These are often insidious and slow in their development so that it may be years before any symptoms develop. The amount of damage to the articular surface of a joint adjacent to the fracture of a long bone has never been stressed. It is, of course, a difficult thing to evaluate unless there is occasion to explore such a joint shortly after the injury. I believe, however, that much more damage than is often recognized may be inflicted on the articular surfaces of such a joint as a result of the forces which produce the fracture, such forces being transmitted through the long bone to the articular surface with resulting trauma to the articular cartilage.

*Torn Ligaments.* Another source of abnormal wear and tear on the joint surfaces is the chronic relaxation of ligaments such as torn cruciate ligaments or tibial or fibular collateral ligaments. The most serious lesions of these ligaments are found as complications of chronic tears of the anterior cruciate ligament. In this condition an anteroposterior instability of the knee joint develops which usually leads to changes in the articular cartilages such as I have previously described. If the thigh muscles, particularly the quadriceps mechanism, are sufficiently well developed, these articular

changes will be delayed or minimized in their extent.

#### CONCLUSION

I have discussed briefly some of the results to be expected as late changes in joints which are the site of internal derangements of various sorts. Many of these may be minimized or prevented by early removal of loose bodies, torn cartilages and other damaging structures. In other cases synovectomy may be necessary to relieve the condition. In many cases, however, much can be done to prevent the damaging development by advising the patient of his condition, by showing him how to develop muscular stability of the joint by means of exercises and by teaching him to avoid the more strenuous activities such as sports, hill climbing and stair climbing. Patients should also be taught to avoid excess weight, a very important factor in many cases. By such means the serious late changes can be minimized in their effect.

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#### DISCUSSION

EDGAR L. GILCREEST (San Francisco, Calif.): Patients with lesions of the knee joint have remissions when the swelling and pain disappear for awhile; they are lulled into lethargy and want to postpone arthrotomy.

That is the time when the surgeon should emphasize that the patient is only putting off the evil day and that later, when he does have the symptoms that will cause him to urge the surgeon to operate upon him, he will never reach full recovery. Of course, he will believe that the operation failed to benefit him very much when the delay has been due either to the surgeon failing to make it clear to the patient why he should have the operation performed early before the degenerative changes occur, or the patient just simply will not take his advice.

It is interesting to note the extensive degenerative changes that take place in the knee joint and when we remember that the knee joint is the next to the lowest joint in the human body, always subject to stress and strain as the patient gets older and heavier, these degenerative changes will increase and even after the operation is performed

and if they have occurred they will continue to increase.

I think we should make it clear to the patient that as he gets older he must remember that he is partially a cripple, his knee joint will always give him trouble, he must expect it and not be disappointed; therefore, his job is to try to prevent damaging that knee joint still more by often wearing a crepe bandage or an elastic bandage. He must know how to put it on so he does not get it too tight. He should be taught how to rehabilitate his quadriceps muscles which always undergo great atrophy after some of these operations; often the surgeon does a clean-cut operation but fails to tell the patient how to exercise his quadriceps muscles. That is a job that should be done for one-half hour every day. I think we often have failed to tell the patient after surgery about dozens of these little things, about how he can restore his knee and get a fairly satisfactory recovery.

We have learned this morning how important it is to perform an arthrotomy which can be done often under local anesthesia; we must see what has taken place there before it is too late and these advanced degenerative changes take place.

WILBERT HERSMAN MCGAW (Cleveland, Ohio): In my experience with about 400 knee cases mostly during the war we made a study at one time of the patellar changes and found that just over 30 per cent of all of our patients with derangements of the knee showed some degree of chondrosis or osteochondrosis of the patella. I believe that no arthrotomy of the knee is complete until the articular surface of the patella has been examined. I think we could borrow a term from Murray and state that there is a definite "time element" in the development of arthritic changes resulting from internal derangements of the knee. At one time we happened to have on the ward three patients: one had a four-day old injury to a knee, another injury was four years old and the other was ten years old. All of these patients had a torn medial meniscus and we happened to have specimens of these various knees whose original injury varied so much in type. The first patient showed no arthritic changes in the joint at all. The second patient who had repeated attacks for four years showed beginning condylar lipping and thickened synovia while the patient with the ten-year old injury showed extensive lipping and softening of the patella, femur and tibia and marked thickening of the synovial membrane.

One can frequently tell within a few days by use of a pneumarthrogram whether or not the subject should be treated conservatively or if a meniscectomy should be performed before arthritis develops.

PAUL B. MAGNUSON (Chicago, Ill.): I have been operating upon many patients with knee injuries over a period of twenty years, and until now I have never had to perform a patellectomy.

Some six or eight years ago I published an article on regeneration of cartilage around the knee joint. We tried to reproduce traumatic arthritis in dogs and we tried all sorts of experiments—putting foreign bodies in them, doing an osteotomy above the knee and putting them under cross strain, traumatizing the cartilage, stripping the cartilage, putting in pieces of bone, foreign bodies in the way of bone and also metal.

We had been working on this experiment for about a year and nothing had happened. The dogs were perfectly healthy; x-ray showed nothing. Examination of the dogs did not even show any swelling.

Finally I had an idea and I said to Dr. Horral, who was working on those animals with me, "You know, we both ought to have a neuropsychiatric examination. We have done all sorts of things to joints here to produce trauma, and we have never allowed these animals to have any trauma to their joints because they are all put back in their cages in the laboratory. Let's take some of these animals out to the farm, and I'll put them in long runways between the runways my dogs are in, and let them race and have a good time."

You would be surprised to see how fast traumatic arthritis will develop after you put real strain on it. The ones that developed it the most rapidly were not the ones who had foreign bodies in their joints but were the ones in which we had cut the internal lateral and the crucial ligaments and folded them back so they would not heal, therefore, there was nothing but skin holding the joint together on one side. These dogs could run just as fast as any of the other dogs as long as they kept on a straight line; I often say they ran like a destroyer and turned like a battleship because when they got to the end of the pen they slowed down and turned very carefully.

In spite of that the constant bumping caused by the relaxation or removal of the ligament and the instability of the joint in six months regularly and uniformly the dogs so treated showed exostosis around the joint that was typical of the exostoses in ordinary chronic hypertrophic arthritis. That does not mean we are talking about atrophic arthritis at all; that is a horse of another color. Just because it happens in the joint there is no reason for considering it in the same category.

In none of these cases have we removed the patella and in none of them have we done a synovectomy except in those in which the synovia was peppered with foreign bodies. In one case I remember taking out one foreign body which was attached to the upper end of the patella and I could not tell the difference, until after careful examination, between it and the patella because it was just as large as the patella.

This erosion does occur and it occurs from constant irritation, in my opinion, and it occurs more

frequently probably in obese, older women or athletes who have had a previous injury than it does in other classes of patients.

In our course of experiments we found that we could scoop out great pieces of cartilage and bone from the surface of the joint, even out of the weight-bearing surface of the joint, and it did not affect the joint at all. We were never able to produce any reaction in the joint by doing that, just removing a large piece from the middle of the joint, even out of the weight-bearing surface.

If that is so in the human, I can see no reason why we should take out the patella if there is any cartilage left at all. This erosion of the cartilage that occurs between the patella and the femur is probably the most common thing that occurs in the knee and it is easy to find on examination when a patient comes in complaining of pain in the knee; certainly we should never fail to sit in front of the patient who should be seated on a table and grind the patella up and down longitudinally against the condyle. You can feel the crepitation and you can cause pain.

That condition is usually found in a patient who appears early but the condition does not show up in the x-ray. I think a good many times it is confused with foreign bodies in the knee because there is locking, the same as though there were an actual foreign body in the knee. What happens? It seems to me it is very easy to explain. The patient straightens his knee; he gets it into almost full extension, lacking probably 15 degrees; the last 15 degrees of extension pulls the patella tight down against that eroded surface and produces a grinding and to me it is a thing exactly like a rough bearing. You get to the point at which the two rough surfaces catch each other and they cause sudden sharp pain. The patient thinks he cannot move his knee, but as soon as he shakes it around and takes the weight off the patella he can move it very easily.

In dozens of these cases we have not removed the patella. We have narrowed the patella when it was wide, and sometimes we have shaved the cartilage down to bare and bleeding bone, in some spots in the same joint. We always shave it so it will form tracks.

In these cases with this type of operation—and I am not talking about the ones that need arthrodesis—if you shave them longitudinally parallel to the motion of the joint, those tracks of cartilage left will act as tracks and the joint will move with them very well. You can hollow out the intercondylar notch where the patella comes in contact and you can cut out the patella so that only the sides contact and those knees will work and go on working.

I may be a little foolish about removing the patella because I have no doubt it gives very satisfactory results in some cases, but the patients that I have seen have caused me to believe they

were not as satisfactory as they would have been if they had had the leverage of the patella through which the quadriceps muscle could apply as power to the head of the tibia.

I have shaved some of these joints down in the last few years until I feared they might not work. Dr. Gilcreest spoke about keeping the quadriceps exercised. It is not a question of keeping it exercised, it is a question of making the patient keep it exercised and in doing that you must put your patient in a position and in suspension so that he can exercise it without its giving him too much pain; then you must see that he does it until he learns how and the learning how should start the day after the operation.

I expect these patients to have 45 degrees of motion in eight days after the operation, and I expect them to get on both feet and walk eight days after the operation. It is not difficult to do if you show the patient how to do it. Get him out of bed; first, teach him how to stand. It does not hurt the knee when he stands with his knees straight. The thing that hurts is throwing weight on the joint with the knee bent. Teach him how to stand, support him and do not let him bend forward; have the knees straight, hips straight, chest up and head up. I never give them crutches, never; some of them may have canes, but those canes are made the right length for that patient to use in walking without stooping forward. Give him enough support.

Then, after you have him standing, stand behind him and with his elbows bent, take firm hold of him at the elbows and walk with him, seeing that when he puts that operated leg forward he gets the knee straight before he puts his weight on it. In three or four days these people are out of the hospital.

I remember Dr. Cubbins came to see one of these procedures. This operation was on a doctor, too. Dr. Ghormley showed us several such cases.

When I was about two-thirds of the way through the housecleaning of the knee, Dr. Cubbins asked if we expected that fellow ever to use the knee again. In a few days Dr. Cubbins visited the patient and the man was exercising his quadriceps, not fifteen or thirty minutes in twenty-four hours but three or four minutes every half hour as long as he was awake. On the eighth day he was up and walking down the hall with me. On the tenth day Dr. Cubbins came in and the man met him at the elevator with his bag in hand on his way home. That man was seventy-two years old.

That is not uncommon. You can do many of these things with these joints without taking out the patella and without doing a synovectomy. I am not talking about rheumatoid arthritis or the type of synovia that is peppered with foreign bodies; I am talking about hypertrophic arthritis. I cannot tell the difference between that and

trauma, and I think trauma has a very definite bearing on it; certainly cross strain, overstrain or faulty weight-bearing of any kind will produce it.

RALPH GHORMLEY (closing): I want to thank the discussers for their very enlightening remarks.

I appreciate Dr. Gilreest's comments. I should have stressed, of course, the importance of exercising the quadriceps on which I think we all agree. As you all know it is sometimes very difficult for the patient to learn to do a quadriceps exercise properly, and the manner in which the exercise is done has to be checked carefully and correct performance insisted upon.

Dr. McGaw mentioned the time element. I mentioned the fact that internal derangements are sometimes long in developing. One has to foresee the possibilities in outlining the immediate treatment for traumatic arthritis of the knee in order to prevent these late changes. I think Dr. McGaw's ability with pneumograms is marvelous. I saw his exhibit at the Academy of Orthopedic Surgeons last winter and it was very enlightening. By the use of pneumograms and several different types of roentgenographic views of knees which I showed you I think we can pretty well diagnose internal derangements of the knees nowadays.

I am sorry Dr. Magnuson disagrees with me on the question of patellectomy. We have had pa-

tients on whom we have performed this operation who returned for the same operation on the other knee. It is significant that they obtain a lot of relief from it. I still believe that many of these patients are benefitted by patellectomy. We use synovectomy only in cases of chondromatosis of the synovial membrane, and occasionally, of advanced rheumatoid arthritis.

We remove loose bodies and bits of cartilage and attempt to restore the contours of the knee to as near a normal shape as possible; we then insist upon a rigid regimen of rehabilitation in order to get the knee of the patient back to as nearly normal as possible. The patients have damaged knees in most of these cases. Their lives will be bound by certain restrictions which might have been prevented if the diagnosis had been made early.

I do not believe anyone should hesitate to do a biopsy and be sure of the diagnosis if the knee is swollen persistently for two or three months and if a reasonable amount of treatment has been given and failure to restore that knee to normal has been noted. Occasionally one finds hemangiomas, xanthomas or synoviomias, in which case the knee never could be restored to normal without surgical treatment. Operation is necessary in many cases to get a proper start toward recovery.



# SOME USES OF UNDETACHED OMENTUM IN SURGERY

JOHN E. CANNADAY, M.D.

*Charleston, West Virginia*

IT has long been a matter of common knowledge among surgeons familiar with bowel surgery that when anastomosis of the large bowel is made in proximity to omentum, the results are definitely superior to those in which the same procedure has been carried out in an abdominal cavity essentially devoid of omentum. In other words, when the omentum is scant or absent, the patient's outlook is not nearly as good and the mortality incidence not inconsiderable.

Senn foresaw the surgical value of omentum as repair material and made use of it in experimental surgery on several dogs. His reported results were gratifying. Accordingly, he later made use of omentum in several of his clinical cases.

Thompson and Pollock used omentum in various types of surgery performed on sixty dogs. Each case was checked by autopsy or by re-operation. Most of the grafts were applied to freshly lacerated or scarified surfaces. The results were most satisfactory. In some cases the omentum was taken from the animal undergoing operation at the time; in other cases the omentum was taken from other animals (dogs) and immediately used. In still other cases the omentum was preserved for several days before using; in still others the omentum had been preserved for as long as two weeks.

In some cases omentum was applied to freshly scarified bowel with immediate take and cessation of bleeding. In other cases omentum was wrapped around the suture line after end-to-end anastomosis between the divided ends of the esophagus. Again, the amputated partially closed end of a bronchial stump was covered over with omentum. In other cases omentum was applied to injured blood vessels of major size with excellent results in nearly all cases. The use of homologous grafts apparently gave equally satisfactory results as compared with the results obtained by the use of autogenous grafts. Likewise, grafts that had been preserved in sterile saline or Ringer's solution and stored in the icebox

anywhere from twenty-four hours to one or two weeks took well and the results were satisfactory. These grafts were applied to pleura, the cut surface and edge of the lung, the bronchus, esophagus, aorta and vena cava. They became adherent and viable in 95 per cent of cases. Four failed to take. Three of these were autogenous; one was homologous. In two of the failures the graft was not sutured in place but was anchored with plasma glue (probably not a fair method due to the constant movement of the lung). Thompson further states that the possible uses of free omental grafts in the thorax are: hemostatic effect, re-enforcement of suture lines and replacement of defects.

Thompson mentions the fact that in 1906 Lowe reported controlling hemorrhage of the liver with free omental grafts and says, "The ability of an omental graft to control a spurting branch of the pulmonary artery by simple application with gentle pressure for three minutes is very dramatic." He suggests also the use of the omentum in controlling bleeding from the spleen and also the kidney. The ability of a free omental graft to adhere and become viable over a suture line, thereby re-enforcing and adding an extra layer of tissue, probably is the outstanding value of the graft. The clinical application of this property in the closure of bronchial stumps and around an end-to-end anastomosis of the esophagus would seem to have great value.

O'Shaughnessy, in his discussion of surgery of the heart with reference to coronary disease, describes the experimental work that he and his associates of the Lambeth Cardiovascular Clinic carried out in regard to patients suffering from coronary disease and other gross cardiac defects. They first began their work by doing experimental procedures on racing greyhounds. They call attention to the well known fact that these dogs are subject to heart disease, frequently having to be put off the track for that reason. A number of these dogs underwent the operation of implantation of omentum into the pericardial sac and the attachment of this

omentum by sutures to the heart itself. They found that the dogs not only tolerated the surgery well but in many instances were enabled in due course to return to the track and to make a good record at their previous occupation. They based the type of operation on the fact that certain cases of coronary disease that were later complicated by pericarditis showed definite improvement and in some cases clinical recovery. Still later they carried out these operations in a series of clinical cases.

O'Shaughnessy and his associates, Dr. Daniel Davies and Dr. H. E. Mansell, with the collaboration of Lord Dawson of Penn, performed twenty operations for cardiovascularization at the Cardiovascular Clinic at Lambeth. These operations were reported in 1938. Fifteen of the patients were suffering from angina pectoris, five of whom died, one on the table, another from uremia three months after operation and three from heart failure two months after operation. The survivors who had been submitted to the full (complete) graft operation made such progress that those who were bedridden at the time became active again, and those who were unable to work were able to resume their employment. There were five patients in this group who had symptoms of cardiac ischemia other than angina and in this entire group there was not a single death caused by operation. In the treatment of coronary disease the main purpose of the graft is to supply blood for the main local circulation. The object in brief is to reproduce by operation the situation which sometimes arises in nature when a pedunculated subserous fibroid suffers partial necrosis because of an inadequate blood supply going through a narrow pedicle. Omentum adheres to the affected area and not only arrests the process but provides a collateral circulation adequate for increased growth in the size of the tumor.

The omental graft serves to supplement the natural collateral vessels in the mediastinum and to give them access to the heart. It has been suggested by Beck (1936) that the graft may serve as a bridge between the right and left coronary vessels. In the operation of cardio-omentopexy the graft is always attached in the region of the apex so that it may form attachments partly in territory supplied by the left coronary artery and partly in territory belonging to the right coronary artery.

The re-enforcement of stomach and bowel

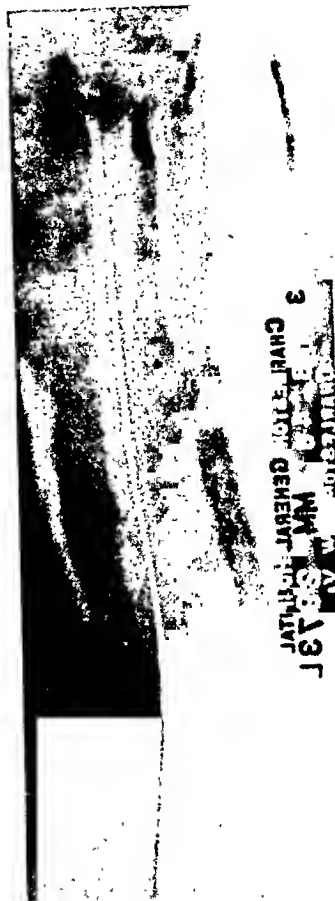


FIG. 1. Compound fracture of forearm showing hiatus in ulna and fracture of radius that has been reduced and is being held in position by a Kirschner wire.

perforation repairs with omentum is a time honored procedure.

Following is a report of a case of severely lacerated wound of the forearm incidental to a compound, comminuted fracture of the radius and ulna in which undetached omentum was used as a graft.

#### CASE REPORT

J. H., a thirty-four year old white male, entered the Charleston General Hospital on October 4, 1945, with a compound, comminuted fracture involving both bones of the left forearm. A considerable portion of the ulna had been torn away. There had been extensive destruction and loss of soft tissue. An attempt had been made to cover the large open wound with an immediate skin transplant. When I first saw him several days later, it was obvious that the attempted skin transplant had failed to serve its purpose. The wound was grossly contaminated; an abundance

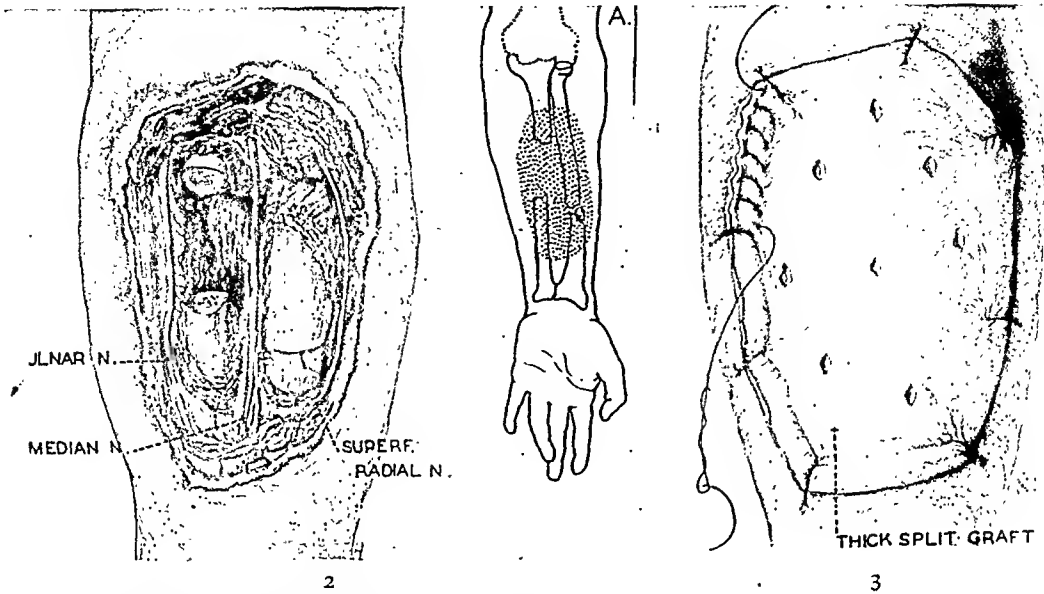


FIG. 2. Drawing indicating some of the exposed nerve trunks.

FIG. 3. Omental implant after it had been freed from its abdominal attachments and covered over with a split thickness graft.

of green pus was present. There had been severe damage to the flexor tendons and muscles. The radial, ulnar, median and several smaller exposed nerve branches appeared to be intact likewise, the radial artery. The ulnar artery had been divided but was not bleeding. The fracture of the radius was reduced a few hours after admission, alignment being maintained by the intramedullary insertion of a Kirschner wire.

The patient had but little control of the thumb and index finger. It was believed that there was great danger of loss of function of the hand and that radical use of omentum might be the means of saving the situation.

Operation was performed on October 8, 1945, by the author. An incision was made in the upper portion of the epigastrium and extended downward for about  $2\frac{3}{4}$  inches. It was noted that there was a non-fatty type of omentum of generous proportions. The hiatus in the forearm was so great in size that practically the entire omentum was required to fill it. The transplanted omentum was held in place by a few interrupted sutures plus a vaseline gauze mechanic's waste, pressure type of dressing. Apparently, rapid union of the omentum took place.

The change that occurred in the condition of the injured forearm was most striking. The evidence of infection in the arm rapidly disappeared. The full function of the thumb and fingers gradually returned.

At the end of ten days, previous to dividing the base of the omental implant, the stump of this graft was partially clamped off each day for ten days, the clamp being left in place for a longer period each time. Following this (November 10,

1945), a split thickness skin graft was applied over the omental implant in the left forearm, also over the omental stump that had been amputated flush with the abdominal wall. The graft over the omental stump in the abdominal wall did not take well and ultimately the stump was mobilized, peritonized and returned to the abdominal cavity. The split thickness graft over the omental implant in the forearm was only partially successful; likewise the application of pinch grafts approximately one month later was not entirely satisfactory; the omental graft later on was successfully covered by a skin flap from the patient's chest.

**Comment.** Previous to the placing of the omental implant into the wound of the left forearm, the condition of the wound was such that the forearm was in grave danger. The apparent prospects were that of a permanently crippled hand. The omental graft promptly overcame the infection and saved numerous exposed tendons and nerve trunks; in other words, it saved the patient from becoming handicapped for life by a relatively useless arm.

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#### DISCUSSION

WALTER G. STUCK (San Antonio, Tex.): I presume I was asked to discuss this paper because of

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my interest in the transplantation of muscle flaps into the hip joint in an effort to provide an accessory circulation. Of course, I know nothing about abdominal surgery so I cannot give an expert opinion on the advisability of bringing a flap of omentum out through the abdominal wall and attaching it to a cutaneous defect in the forearm.

In addition to the work of O'Shaughnessy, which Dr. Cannaday mentioned, Friedbaecher and Morison transplanted flaps of omentum to provide accessory circulation elsewhere. It stands to reason that a flap of this sort would be more vascular than a flap of skin that had been lifted off the front of the abdomen. I know that muscle flaps can be transplanted successfully into the heart wall, the cerebral cortex and to the medulla of bone. Whether the use of omental flaps will

achieve the same results or not, I do not know; but in this case Dr. Cannaday has demonstrated that the flap will unite to the forearm soft tissues even in the presence of infection.

JOHN E. CANNADAY (closing): I have nothing further to add except that since the wound in the arm, when I first saw it, was reeking with green pus infection, I believed I was dealing with a serious emergency and one that would have to be dealt with very radically if the patient's arm or its function were to be saved.

It occurred to me at the time that the use of an omental transplant would be the only means by which this could be done. I had the impression that omentum was capable of taking care of almost any kind of local infection if it acquired a sufficient hold on the infected tissue.





# TWENTY-FIVE EASY WAYS OF GETTING INTO TROUBLE IN THE CARE OF FRACTURES\*

FRASER B. GURD, M.D.

Montreal, Canada

THE modern development of fracture treatment has been continuous in point of time with the active life of the present author. The conferring of a baronetcy upon William Arbuthnot Lane in 1913 gave official recognition to the renaissance of fracture care. During the first stage of the war (1914-1918) definite advances were made, more especially by popularization among surgeons in the British, American and Canadian armies of the methods of Owen Thomas through the protagonism of Sir Robert Jones. Since 1918 the frequency with which monographs and textbooks have been published bears witness to the fact that the problems of fracture treatment have become more and more important both in the medical curriculum and in the attention of both general and orthopedic surgeons.

In his Presidential Address before The American Surgical Association in 1946, Dr. William Darrach chose as his title "Treatment of Fractures."<sup>1</sup> He began his address with the following sentence: "A fracture patient is an individual whose normal activities, both vocational and avocational, have been interrupted by an injury . . . The damage is rarely limited to the bone. Associated soft-part injuries are often of greater importance and need more careful attention than the fracture itself." He states further in his summary: "The object of treatment is to return the individual to a normal state as completely and as rapidly as possible . . . In planning treatment each case must be studied as an individual problem and all the factors evaluated. Success will depend more on a correct understanding of the problem and a wise plan of action than on the methods by which that plan is carried out."

In the preparation of this address I believed that the purposes indicated by Dr. Darrach might well be studied through a consideration of the pitfalls which are likely to be met with

in the treatment of these patients. If the title is deemed to be facetious and perhaps provocative, these qualities are not accidental. The twenty-five errors which are touched upon do not exhaust the possibilities. I believe, however, that were these avoided, the results obtained by surgeons throughout the world would be improved.

I shall mention only in passing the benefits of protective splinting in the initial transportation of the injured. Omissions in this initial stage of care may institute a train of stubborn troubles but are largely beyond the direct control of the attending surgeon. There remains a sufficient number of ways of courting trouble once the patient is in a position to come under definitive care. Errors can be committed before, during or after the definitive treatment of the injury itself. The following are nine ways of getting into trouble before treatment of the fracture is actually instituted.

## ERRORS MADE BEFORE TREATMENT OF THE FRACTURE

The first and most serious error is *failure to assess the severity of associated traumatic shock*. A clinical analysis of the vital signs must precede the local and general physical examination. Blood pressure estimation is of major importance in fractures of ribs or skull and in cases of multiple fractures which involve the major bones. Failure to be fully aware of existent or impending shock is of especial importance when a major operative procedure is on the point of being undertaken. However, this error may be even more dangerous when no immediate treatment is planned, as is illustrated by the following case: A young man, age twenty-two, was thrown from a motor cycle, receiving a blow which resulted in a fracture of the pelvis. (Fig. 1.) The fracture was diagnosed quickly but there was no skin wound. Accordingly the available surgeon turned his attention

\* From the Department of Surgery, McGill University, and The Montreal General Hospital, Montreal, Canada.

to the young man's companion who had a severe compound shoulder wound. While the latter patient was being operated upon, our man with the fractured pelvis slipped into a profound state of shock, became pulseless and without recordable blood pressure. A very large hematoma was discovered over the fracture site and massive transfusion was required, which fortunately was effective.

Our second error is only slightly less critical. It consists in *failure to diagnose concealed non-bony injuries*. The young surgeon in training must be taught to miss nothing by developing a clinical approach to the injured patient which reveals the most while disturbing the patient least. There is no substitution for acuity of observation. Fractures of ribs, spine and pelvis may demand that the urinary bladder be catheterized. A small head wound may demand a neurologic examination. The chest and abdomen may contain damaged viscera. Worthy is the surgeon who diagnoses a traumatic hemothorax, pneumothorax or a ruptured diaphragm through the medium of eye, hand and ear. The familiar conjunction of alcohol with a fall lays a special trap for the unwary. The flaccid patient may be inebriated indeed but he may also be incapable of drawing attention to his broken neck. It is characteristic of trauma to transcend the boundaries of our professional subspecialties.

Third, stands the error of *failing to diagnose all concomitant fractures* and their complications. Even in the conscious patient diagnosis demands not only thorough examination of all bones and joints but also repeated questioning to exclude painful lesions which may appear to the patient to be of minor importance at the time. The integrity of trunk nerves and major arteries must be checked, bearing in mind the fractures most commonly associated with nerve injury. For example, a common minor, associated injury is a fracture of the upper end of the fibula, but simultaneous injury to the common peroneal nerve may lead to prolonged disability and possibly serious legal consequences if its presence goes unrecorded. In the event of either vascular or nerve injury being demonstrable when a case is first seen, it is a wise precaution for the practitioner or surgeon in charge to obtain the help of a fellow practitioner in order that protection may be available should criticism be encountered later.



FIG. 1. Simple fracture of the pelvis which led to formation of a hematoma so extensive as to threaten life.

Examination for concomitant fractures is facilitated if the mechanism of the more obvious injury is known. For instance, falls on the feet may fracture or dislocate any part of the weight-bearing skeleton, while falls on the hand may similarly disrupt any part of the upper extremity. Damage to the supraspinatus tendon not uncommonly accompanies a Colles' fracture. Diagnosis in the patient rendered unconscious by a head injury requires added care and thoroughness.

Our fourth error is *failure to obtain adequate preoperative x-ray photographs*. The purposes of this initial x-ray study are as follows: (1) To exclude bony injury in cases in which by clinical examination the possibility of fracture is suspected but not proven; (2) to determine the exact type of injury with special reference to information which will permit the mechanism of production to be inferred; (3) in order that prognosis may be indicated to the patient and to other interested parties; (4) for purposes of permanent record, especially in cases in which it is clearly impossible to avoid a certain degree of permanent incapacity; (5) to avoid oversight of concomitant fractures, such as the carpal scaphoid in the case of fracture of the head of the radius or compression fracture of a lumbar body associated with fracture of the os calcis. In order to be "adequate," x-rays must include at times a number of oblique views in addition to true anteroposterior and lateral projections. Fractures of the carpus, especially

of the triquetrum, may be overlooked unless oblique views are taken; while multiple films of the fractured os calcis are required if all possible help is to be obtained from the radiologist.

If clinical signs suggest fracture but x-ray examination fails to reveal a solution of continuity of the bone, x-ray examination should be repeated after sufficient time has elapsed to permit bone absorption at the site of the fracture. In the interval trouble will be avoided if such cases are treated as though fractures were proven to be present. Perhaps the most important injuries of this sort which are likely to be overlooked in early x-rays are those of the carpal scaphoid and of the lumbar bodies, the latter being the type of case to which the term Kümmell's disease is applied.

The fifth easy way to court trouble is by simple *failure to identify films*. Two young men were skiing in the famous hills of our Laurentians on a recent occasion and within a few minutes of one another each sustained an injury to a lower extremity. They were admitted to the small hospital available for such cases where x-ray examinations were made. The patient who came to my attention was placed in a plaster cast from the toes to below the knee. He was presented with an x-ray film showing a trivial crack in the lateral malleolus of the external rotation type. He was instructed to walk and was placed upon the train for Montreal. Upon arrival at the Herbert Reddy Memorial Hospital in Montreal he complained bitterly of the difficulty which he had had in reaching the city. It appeared that the slightest movement in bed caused pain. X-ray examination was repeated which revealed fractures of both bones of the leg.

The victim of this mixing of x-ray pictures was paradoxically amused when the situation was explained to him. His amusement was due to the fact that the other young man, with the simple crack in the lateral malleolus, had been transported to Montreal by ambulance at a very substantial expense.

*Failure to interpret x-ray photographs* is our sixth cause of difficulty. Errors of this type are perhaps most easily made in the region of the carpus where the multiplicity of bones and joints makes the exact interpretation difficult, especially to the inexperienced. Mid-carpal and mid-tarsal dislocations may give very misleading x-ray appearances owing to super-

imposition of small faceted bones. In a case which came under our observation recently a displaced fragment of a fractured os magnum was mistaken for a portion of the scaphoid. The diagnosis was made of fracture of the scaphoid with wide separation of the fragments and on this diagnosis the scaphoid was excised. At operation the scaphoid was found to be fractured indeed but without displacement to the perturbation of all concerned.

Another group of cases in which x-ray interpretation is of first importance to treatment and prognosis is the broad group of pathologic fractures.

The seventh error is *failure to recognize the mechanism of production of the injury*. The patient's own account of the accident will often throw much light upon the mechanism and should be correlated with the preoperative x-ray films. For example, when the elderly lady is emphatic that her leg gave way and she fell and x-rays show an abduction fracture of the femoral neck, a good prognosis can be assured. Conversely, a fall on the hip with an adduction fracture results in a situation of greater severity and difficulty. In Smith's fracture at the wrist the primary pitfall of mistaking the lesion for a Colles' fracture is avoided if the mechanism is studied.<sup>2</sup> Tibial flexion or adduction injuries of the ankle joint are relatively uncommon, but it has been our experience that these fractures have been seen for serious deformity many months after injury, and usually as a result of failure to recognize the nature of the injury at the initial treatment. It is my experience that most fractures of the posterior malleolus of the tibia can be considered to be caused by an external rotation mechanism. If these injuries are immobilized with the ankle in forced internal rotation, a large number of open operations will be rendered unnecessary.

The eighth error is *inadequate records*. This applies particularly to the initial recording of primary injury to vessels and nerves. The record must be clear as to what lesions already existed at the moment the patient first came under one's care. One must bear in mind the frequent association of damage to the radial nerve and fractures of the humerus, of the common peroneal and the fractured head of the fibula, of the ulnar and fractures of the median epicondyle of the humerus. Less commonly seen are lesions of the circumflex nerve in shoulder injuries, and the rare but extremely

painful median nerve neuritis associated with Colles' fracture.<sup>2</sup> The record should contain a note on the state of the arterial pulsation in any injured extremity. It is the duty of every surgeon to avoid unwarranted criticism. In this connection failure to record the difficulties inherent in the individual case is to court trouble.

Before treatment is begun our ninth and final preoperative error is *failure to notify all concerned of the prognosis* which may be anticipated. The late Dr. J. M. Elder was the most impressive bedside teacher under whom it was my privilege to study. He was accustomed to state his views on this subject in the following terms: "Always bear in mind that your patient is but little interested in your diagnosis. He is somewhat more interested in the therapy employed since he will be more or less uncomfortable depending upon your decision in this regard. However, he is profoundly interested in your prognosis, both in so far as this refers to the eventual result, and more particularly to the length of time which will be required for such result to be obtained."

The patient, one should add, cannot be expected to comprehend the complications and delays which may confront him unless these are explained to him. The same notification must be given to all interested parties such as parents, guardians, insurance companies and compensation boards. It is especially important to indicate in advance the probable results of a particular injury when the end result is liable to be unfavorable. However, this approach can be of help even in minor trauma. For example, if one is careful to inform the mother of a child with a fractured clavicle that if all goes well a lump will appear over the fracture in three weeks' time, alarm on the part of the parent when the lump appears is replaced by a measure of delight.

Again, the parents of children suffering fractures of the lower end of the humerus should be advised of the possibility of a cubitus valgus developing late, with possible loss of function of the ulnar nerve. They should be told to report the development of any weakness of the hand. Similarly, late deformities and disabilities following epiphyseal injuries should be warned of in advance. The high risk to life of hip fractures in the aged should be mentioned to the patient's family.

#### ERRORS DURING ACTUAL TREATMENT OF FRACTURES

We are now in a position to begin our active treatment, having avoided nine easy ways of getting into trouble before treatment is even begun. Our tenth is *delay in fixation*. Such delay is difficult to excuse once the patient comes under our care. The Thomas splint resulted in a distinct decline in mortality from fractured femur when it was introduced during World War I. It is still the first fixation device for this type of injury. In the lower leg and ankle the pillow splint will give fixation while definitive treatment is being arranged and will also minimize swelling.<sup>3</sup> A folded newspaper with an aperture for the thumb will immobilize a Colles' fracture. It is obvious that delay in fixation may add further trauma to local soft tissues, but it is not always appreciated that this error is a potent cause of acute bone atrophy as is illustrated by the following case. Mrs. C. M., age fifty-three, suffered a Colles' fracture without displacement late in August, 1947. Her physician decided to omit fixation entirely in her case and simply placed the forearm in a sling. Nine weeks later she was referred to me with severe pain and swelling of wrist, hand and fingers, and loss of almost all movement. I applied a plaster at once and obtained the x-rays shown. (Figs. 2 and 3.) Acute bone atrophy was present in wrist, hand and fingers. The frequent finding of this lesion in fractures in which fixation is delayed has convinced me that the relationship is more than accidental.<sup>4,5,6</sup>

Eleventh is *delay in reduction*. In general it may be said that delay in reduction is of less importance than delay in fixation. However, in certain fractures delay in reduction may seriously jeopardize the ultimate result. Paramount among these is the supracondylar fracture of the humerus, followed by a variety of fractures about the ankle, wrist joints and fingers.

The majority of surgeons and practitioners appreciate the importance of our twelfth error which is *inadequate reduction*. In fact, this aspect of treatment is often overstressed to the neglect of other aspects. Nevertheless, it remains a general rule that the more perfect the anatomic reduction the shorter the period of total disability and the better the end result obtained. In reaching a decision as to whether

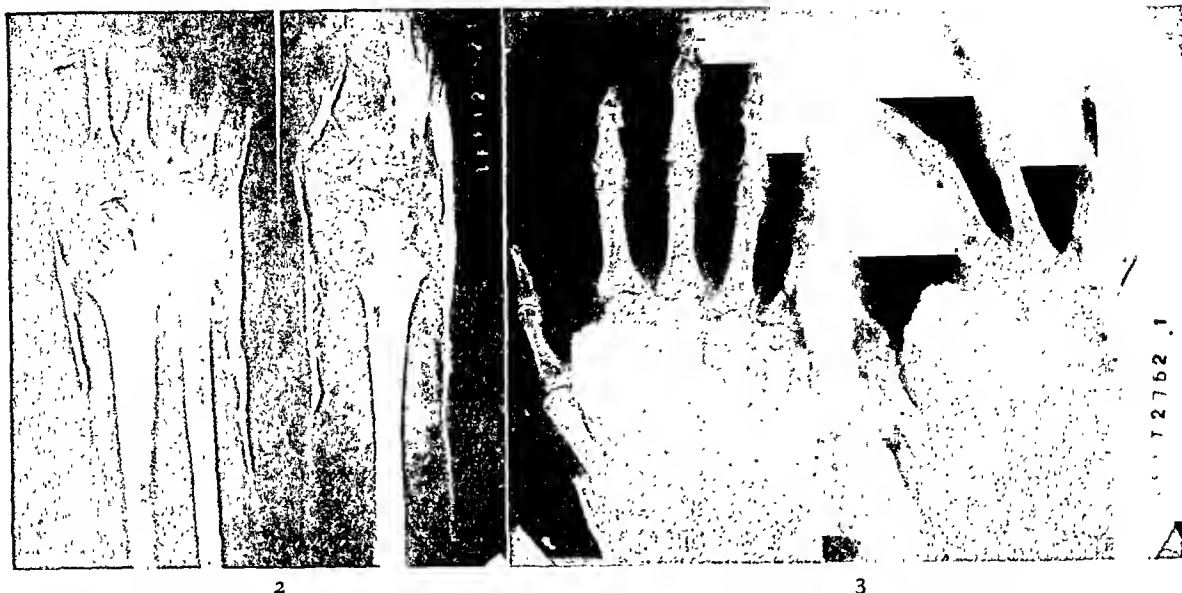


FIG. 2. Case C. M. Acute bone atrophy following Colles' fracture of left wrist treated without fixation for nine weeks.

FIG. 3. Same case as in Figure 2 showing marked bone atrophy of phalanges of left hand.

one should endeavor to improve the reduction obtained at the first attempt, one must weigh the consequences of added trauma which always accompany repeated manipulations. The growing child and especially the newborn can compensate for degrees of displacement which would not be acceptable in the adult. Perhaps the most common and serious error occurring during attempts at reduction is distraction of the bone ends. This is an especially common cause of trouble in fractures of the shaft of the humerus, and in my opinion all reduction procedures involving heavy traction are to be avoided in this fracture.<sup>7</sup>

The thirteenth source of trouble is *undue roughness during reduction*. There is no practical method of measuring the forces exerted in the manipulation of the individual case. However, if every movement to which a fractured limb is subjected be decisive and purposefully planned, a minimum of added trauma to soft parts will be produced. It is important to bear in mind that the periosteal tube about the bone may be partially intact when reduction is started and should not be damaged further by rough handling. In fractures of the femoral shaft, for example, a thick strip of tendinous tissue forming the muscular insertions on the linea aspera may be torn. A tongue of this tissue may become interposed between the bone ends during distraction and non-union may

result, as has been brought to my attention by Dr. R. R. Fitzgerald.

The unfavorable consequences of *repeated attempts at reduction* have been mentioned before but the matter deserves to be listed as our fourteenth cause of trouble. In my opinion it is the most important single cause of acute bone atrophy, especially in fractures in the neighborhood of joints. The two joints most frequently the site of repeated attempts at reduction, namely, the wrist and ankle, are precisely those areas in which acute bone atrophy is most frequently seen as a serious complication.<sup>4,5,6</sup> The following case is typical:

Miss M. G., age fifty-one years, fell on shipboard and suffered a Colles' fracture of the left wrist. An immediate attempt at reduction was carried out by the ship's surgeon and the forearm was fixed in splints. Reduction was again attempted under local anesthesia three days later upon arriving in port and a posterior plaster mould applied. Two weeks after injury a further attempt at reduction under general anesthesia was made and a heavily padded circular plaster bandage applied. The patient was seen by me eight days after the third attempt at reduction. Both active and passive movements were painful and fingers and hand were very swollen. She volunteered the information that prior to the third attempt at reduction the fingers had been freely movable and the

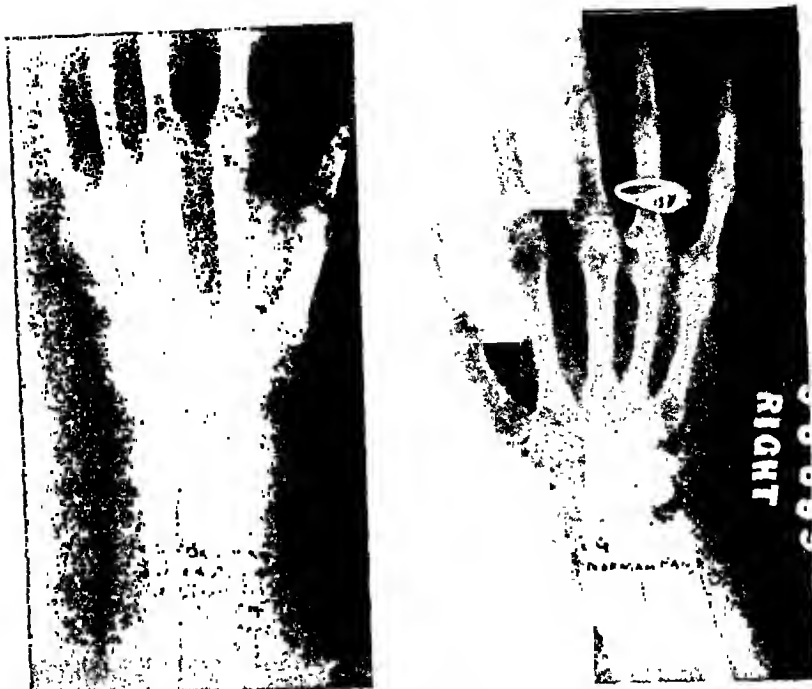


FIG. 4. Case M. G. Roentgenograms both hands, seven weeks after Colles' fracture of left wrist. Reduction was attempted three times, followed by development of acute bone atrophy.

hand relatively painless. Plaster was reapplied without padding but the pain increased and the limb became useless. X-ray examination seven weeks after injury showed well marked patchy bone atrophy to be present. (Fig. 4.) This atrophy involved the lower end of the radius and ulna and all the carpal bones, both extremities of the metacarpal bones and to a lesser extent the phalanges. The joint contours were distinctly shown. Union at the site of the fracture appeared to have progressed satisfactorily with but little displacement. Treatment consisted in the avoidance of any movements which caused even the slightest pain. However, many months were required before recalcification occurred. Functional recovery was eventually complete and the patient resumed her duties as a skilled pianist.

The fifteenth error is the use of *excessive padding under plaster*. Two risks are associated with this fault: First, a slipping of the bone ends is invited. Second, even if loss of reduction does not occur, immobilization may be inadequate for prompt union. It is perhaps true that greater skill is required in the application of plaster when little or no padding is used. However, given reasonable care, the risks are less than those which follow the application of thick padding. It should be added that the

skin-tight plaster should be reserved for the limb in which little or no swelling is present.

Our sixteenth way of getting into trouble consists of a broad group of *technical errors during open operations*. Technical mistakes which result in infection, gangrene or skin loss are not frequently encountered today. However, any elective procedure involving open reduction, internal fixation or removal of a surplus part of the skeleton<sup>8</sup> requires the most perfect of operative technic despite our progress in bacteriostasis. The technical errors which I would emphasize are the following: (1) Too small or badly placed incisions; (2) failure to obtain good reduction before fixation, especially in the pinning of fractures of the femoral neck; (3) permitting the presence of distraction of bone ends during application of a plate; (4) too short plates and too short screws; and (5) improper metals or combinations of metals.

To conclude the list of mistakes which may be made during actual treatment of the fracture, I would list as our seventeenth a group of *errors in treatment of compound fractures*. A large literature is appearing on the primary suture of these injuries. I must express the hope that the lessons of two wars will not be forgotten, for primary closure of contami-

nated wounds is a satanic trap to the surgeon of less than mature judgment. Conservative excision, wide incision, open packing and delayed suture must be the program in the majority of cases.<sup>9-14</sup> Delay in operation, inadequate operation and overconfidence in bacteriostatic drugs and sera might well sum up the pitfalls in this important class of cases. The marked improvement in results during our lifetime has been due largely to the more widespread appreciation that adequate operative treatment must be carried out, followed by the planned timing of dressings and secondary operations.<sup>15,16</sup> The bacteriostatic and bactericidal drugs and the wider use of transfusions have been important adjuncts. The introduction of new metals has made internal fixation more applicable to compound as well as to simple fractures. The pneumatic tourniquet has aided in the economy of blood with less danger of secondary damage.

#### ERRORS DURING THE HEALING PERIOD OF THE FRACTURE

Under the eight preceding headings we have considered the points of difficulty during the actual reduction and fixation of the fracture. At this juncture there is no more common error than number eighteen which is *failure to maintain close observation during healing*. Coupled with this heading is the constant necessity for promoting the patient's morale through attention to his diet, his rest and his emotional acceptance of the inevitable prognosis in terms of end result and time required. It is during healing that the patient can do most to help himself, and the confidence in his advisors which he has acquired since his injury must be maintained until healing is complete and function is restored.

*Failure to check maintenance of reduction by x-ray films* is the nineteenth pitfall. The immediate postreduction film may show adequate replacement of the bone fragments, yet later examination reveal that the fragments have slipped out of place. This is particularly liable to occur if excessive padding is applied beneath the plaster, if joints above and below the fracture are not fixed or if marked muscular atrophy has taken place. Clinical attention to the patient's own symptoms and sensations will assist in the timing of check x-ray films, enabling slipping to be diagnosed earlier than by any simple strict routine. Both clinical and

radiologic guides must be used in the timing of changes of plaster, institution of exercise and reassessment of prognosis. Everyone interested in the treatment of fractures realizes that fractures of both bones of the leg, especially of the torsion type, are extremely difficult to hold in position. As McKim has pointed out, slipping of such fractures is evidently due to atrophy of the thigh and calf muscles, permitting displacement of the proximal fragment of the tibia owing to movement of the femur in relation to the cast. He has made a specific recommendation regarding the care of such patients in order to avoid such displacement.<sup>17</sup> In emphasizing adequate x-ray control during healing, one must insert a warning against too frequent x-ray exposure. Wilkins and Regen have presented evidence that bone growth and bone phosphatase activity can be impaired by overdoses of roentgen radiation.<sup>18</sup>

The twentieth error is *maintenance of the limb in a non-physiologic position*. It is occasionally necessary to immobilize a limb in an abnormal position at the time of the initial reduction. However, this position should not be maintained any longer than is absolutely necessary. Whenever possible the maximum functional position should be maintained throughout fixation. A good guiding principle is to place the limb so that as many as possible of its normal functions can be carried out despite the presence of a fixation device. McKim defines the functions of the hand as follows: (1) to feed oneself, (2) to earn a living and (3) for purposes of offense and defense. His teaching is that a good plaster can immobilize the wrist while preserving all three of these functions. He adds as a general dictum based on his own wide experience, and I quote: "Joints do not tend to become stiff when fixed in a functional position."<sup>19</sup>

*Application of unpadded plaster while edema is present* is our twenty-first mistake. This applies especially to the unpadded walking cast.<sup>3,20-24</sup> When such a cast cannot be applied before swelling has occurred, it is important to wait until all edema has been dispersed. Otherwise stiffness and swelling will result and the value of the method will be lost. Furthermore, the limb will tend to chafe inside the plaster after periods of recumbency, with damage to the skin and loss of absolute fixation.

The twenty-second error is *failure to instruct in the use of appliances*. In the use of crutches



severe falls are frequent because the surgeon has failed to instruct the patient to "walk up to your crutches, never get ahead of them." Most cases of crutch paralysis occur because the patient has never been told not to bear weight in the axillae. Safe walking in the Thomas walking caliper requires specific instruction, especially in going up and down stairs. The patient must appreciate the necessity for negotiating stairways in sideways fashion, leading off with the caliper when going down but with the sound leg when going up. The patient in a walking cast must be told to avoid a gait which involves extreme external rotation of the foot. Such a gait is instinctive whenever the ankle joint is fixed; but if it is allowed to become habitual, a traumatic flat foot will result.

Our twenty-third and easiest of all ways of getting into trouble in the care of fractures is *too early mobilization or unprotected weight-bearing*. Optimism on the part of doctors regarding the length of time required for consolidation of fractures of the femur and tibia as well as of the bones of the foot is, I believe, one of the commonest and most serious errors made in the treatment of fractures. The same applies to fractures of both bones of the forearm. As a general rule it would be wise for us all to read months rather than weeks into the recommendations made in most textbooks. During a long experience in the examination of victims of injury for medicolegal purposes I have come to the conclusion that too early mobilization and too early unprotected weight-bearing has been the most important cause of prolongation of temporary total disability and of increase in the permanent partial disability. It would be easy to accumulate large numbers of cases to support the above thesis. I believe, however, that the frequency of bending of fractures of the tibia, refracture of the femur as well as the comparative frequency of true non-union in fractures of the ulna should convince anyone of the correctness of this statement.

Our twenty-fourth method of delaying our good result is *delay in rehabilitation*. Perhaps this is better described as neglect to maintain the patient in the best possible general and local condition. Attention to diet and factors of morale must be combined with instruction in local and general active exercise. In this con-

nection occupational therapy offers considerable aid.

Our final warning, number twenty-five, goes hand in hand with the previous heading and consists of *too early and ill conceived physiotherapy*. The older textbooks advised early passive movement and this fallacy has taken years for exposure. The dangers of stiffness and vasomotor disturbance will be largely avoided if passive movement is forbidden. However, overly vigorous active motion which causes pain may be equally damaging. Finally, the surgeon must check that the active exercises being taught to the patient are not simply fatiguing accessory muscles without action on the part of the involved muscle group which the therapy should be aiming to restore. Patients endeavoring to restore flexion to fingers are frequently found to be working only the intrinsic muscles of the hand, flexing and extending the metacarpophalangeal joints, often without any perceptible contraction of the flexors in the forearm being achieved. Fractures about the elbow must be protected from physiotherapy for the longest possible time. The consequences of even the mildest passive stretching in this area are particularly severe. In my practice I do not wish to be quoted as opposed to physiotherapy, but when I am asked how soon after injury an elbow fracture should be turned over to that department, I generally reply: "Any time after the eighth month."

#### CONCLUSION

We have concluded our account of twenty-five easy ways of getting into trouble between the beginning and end of our contact with the fracture patient. Nothing less than a continuing interest in improving our results must be our constant care if we as general or community surgeons are to retain our right to treat this class of trauma. In the beginning I quoted from Dr. Darrach's synthesis of the whole problem of fracture care into a "wise plan of action." No one was better qualified than he to emphasize the overriding importance of that quality of wisdom.

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# EXPERIMENTS ON THE HOLDING POWERS OF VARIOUS TYPES OF METALLIC INTERNAL FIXATION FOR TRANSCERVICAL FRACTURES OF THE FEMUR\*

PAUL H. HARMON, M.D.†  
*Oakland, California*

DAN R. BAKER, M.D.  
*Dayton, Ohio*

AND

JOSEPH H. RENO, M.D.  
*Allentown, Pennsylvania*

WHILE metallic internal fixation for transcervical fracture of the femur has been in common use for more than fifteen years, it has only been during the last few years that a critical analysis of the results has pointed out some of the factors that must be observed to obtain the best results for each individual patient. It is generally agreed that early control of the patient by the surgeon, anatomic reduction, secure fixation and regular and prolonged postoperative supervision are required. Certain of the detailed steps of this program are still under discussion.

No less than thirty different types of metallic fixation, more than fifty accessory gadgets for measuring, sighting, directing and placing the fixation material and hundreds of articles describing the use of these numerous and ingenious devices are found in the surgical literature. No attempt will be made to catalogue this knowledge, but a safe conclusion to be drawn at this time is that the results can still be improved.

Early and exact reduction undoubtedly conserves the blood supply which is so important in this fracture. Metallic fixation is to be regarded only as an efficient and temporary internal splint to carry the patient over the period until the fracture heals. Healing will be shorter the more efficient and the less destructive the type of internal fixation used and the less traumatic the technic of placing the fixation device. Absorption of the neck is due to excess motion during the healing period and since all non-viable material produces pressure necrosis and loosens if sufficient strain is

thrown upon it it is desirable to utilize the most efficient immobilizing devices and to obtain the most stable reductions.

It is difficult to segregate and analyze data in the human patient. However, the proof of several points appears now to be beyond question. Compere and Wallace have furnished experimental proof that early and accurate reduction leads to prompt union with a viable head. The same conclusions are inferred from the statistics of individual surgeons who have reported a high percentage of favorable results. The elimination of shearing stress and its corollary, a stable reduction, has been pointed out by those who have given particular attention to the inclination of the fracture line (Pauwels, Eyre-Brook and Priddie and Linton) and by those who have advocated various types of osteotomies. Wellmerling has pointed out the advantage of utilizing the thick cortical bone a short distance down the lateral femoral shaft to hold the internal fixation pin which is driven upward through the neck and head at as oblique an angle as possible. This assumes the use of longer fixation materials and their passage through the inferior third of the proximal femoral neck, a region where osseous trabeculae are best developed. McElveny pointed out that temporarily increased longitudinal traction accompanied by medial displacement of the lower fragment will often secure rotation of the head with a more horizontal and stable fracture line.

It has been the experience of all surgeons that it is impossible to determine the time of secure osseous union in transcervical femoral

\* Experimental work for this paper was carried out at The Guthrie Clinic and The Robert Packer Hospital, Sayre, Pa.

† Director of Orthopedic Surgery, The Permanente Foundation Hospital, Oakland, Calif.

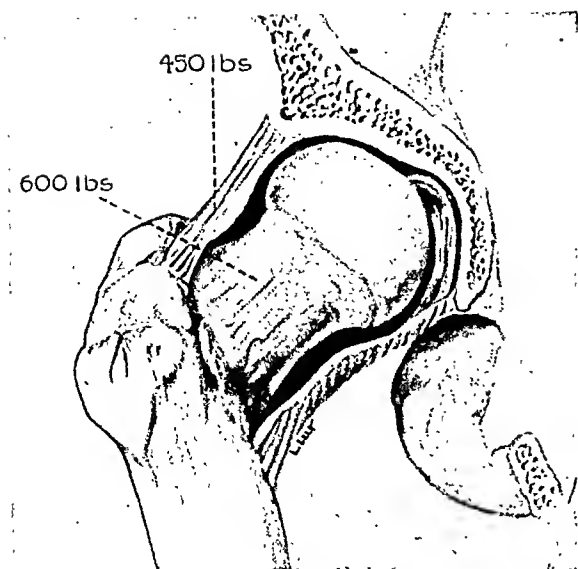


FIG. 1. Diagram summarizing average forces required to disrupt certain structures about the hip in fresh unpreserved cadaver specimens. The figures at the capsule in the femoral neck were the averages required to rupture these structures by a distracting force. Average crushing force to fracture the neck is 1,500 to 2,000 pounds; averages of four tests.

fractures until it has become far advanced. Internal fixation as a result must be left in place for many months after resumption of weight-bearing. The introduction of autogenous grafts appears to accelerate union, but the majority of surgeons consider that they are unnecessary in fresh cases except in unfavorable instances and in those showing complications in which extra stimulation is required. There is no agreement on schedules for post-operative care. Some surgeons favor extremely early and vigorous use of the extremity while others recommend rest.

The minimum of trauma in transporting the patient and in securing reduction compromises the blood supply the least and adds to the comfort of the patient. Skeletal weight traction (5 to 8 pounds) with internal rotation and local anesthetization of the hip area is unquestionably the least traumatic method of obtaining reduction. Techniques are also available (Harmon) for reduction and insertion of the internal fixation without transferring the patient from his bed. This undoubtedly minimizes trauma.

This paper is an experimental investigation of the holding power of various types of internal fixation. The conditions for the tests were uniform and were carried out on preserved upper femora of dissecting room cadavers.

(Figs. 1 and 2.) The values obtained are, of course, not identical with those of living man because of the difference between preserved dead bone and viable bone. The comparisons obtained are likely to hold for the same region in living bone. It is recognized that the type and technic of inserting internal fixation is not the sole factor involved in treatment of transcervical fractures in the human, but a study of the mechanics of internal fixation is likely to improve the practical application of the same devices in patients. The data summarized in this report were secured in experimentally produced fractures across the femoral neck of 242 selected specimens\* from approximately 400 trials. The estimations were of two types (Figs. 3 and 4): the holding power against a distracting force directed coaxially with the neck and a determination of the resistance of the specimens to a superior-inferior crushing force. As will be described later the experimental specimens gave way in different zones, varying with the type of fixation employed and the hardness of the material.

#### EXPERIMENTAL METHODS AND MATERIALS

Five or 6 inches of the upper femur were removed from cadavers by cutting away the joint capsule and transecting the shaft with a saw. The specimens were kept moist by towels soaked with preservative solution during transportation and until the tests were carried out. A superior-inferior cut with a saw was made across the mid-portion of the femoral neck at a 30 degree angle with a long axis. (Figs. 5, 6 and 7.) The tubular subtrochanteric shaft was mounted in a vice in the laboratory and the fixation material introduced from the trochanteric side with an assistant holding the femoral head in place. Observations were made during the insertion of the fixation material, and approximately every tenth specimen was subjected to roentgen examination as a control on the depth and direction of insertion of the metallic fixation. The experimentally fixed fractures were then subjected to distract-

\*The authors are indebted to the Professors of Anatomy of the following medical schools who kindly placed the dissection room specimens at our disposal: The University of Pittsburgh, The University of Buffalo, The University of Rochester, Syracuse University, The University of Pennsylvania, Temple University and The Jefferson Medical College of Philadelphia.



FIG. 2. Various sizes of long slender threaded hexagonal headed screws. (Reproduced by courtesy of the *Journal of Bone and Joint Surgery*.)

tion and crushing, between the tables of a beam-balanced hydraulic press of a type commonly used in engineering laboratories in determining tensile strengths.\* Observations on the specimens were made during and after the tests. The end point of the test was the earliest grossly detectable sudden yield or separation at the fracture site or elsewhere in the specimen. This might be detected either by direct inspection or from a sudden deflection of the balanced beam which would indicate giving way of the specimen. The portion of the specimen which broke and the mode of separation varied with the type of fixation. While it was impossible to secure enough specimens to make the results of statistical order, sufficient duplications of each type of test were performed in order to secure fair median values. The numerical values of these tests are recorded in pounds in Table 1. Photographic and roentgen records of the results in representative selected instances were made. (Figs. 5, 6 and 7.)

Twelve types of fixation materials, Tables I and II, were selected as being representative of

\* These estimations were carried out in the testing laboratory of The Lehigh Valley Railroad, Sayre, Pa.

all types of internal fixation for transcervical fractures of the femur. The Smith-Petersen tri-bladed nail and the Cubbins-Callahan-Scuderi flange were selected as representatives of sharp, rigid fixation materials. The blade of the Neufeld nail has similar properties. The Thompson Z-nail was representative of a semi-rigid device. The group of large helicoid devices was represented by the Moreira lag screw, the Lorenzo screw and the Lippmann corkscrew bolt. Smooth rigid pins were illustrated by stainless steel Steinmann type pins ( $\frac{5}{32}$  inch in diameter). Larger screws, such as the Geckler screw and the Venable type large Vitallium wood screws, were used. Slender threaded pins of the three types described by Moore, Compere and Harmon were used. The proximal half of the Moore pin is unthreaded while threads extend the entire length of the slender shaft of the two latter type slender pins. The Compere threaded wires are 0.080 inch in diameter with fifty-six turns to the inch. Two sizes of the long slender hexagon headed screws (Harmon), 0.125 inch and 0.156 inch in diameter threaded with a sharp die, 32 turns to the inch and with respec-

tive root diameters of 0.094 inch and 0.120 inch, were tested. Thin stainless steel washers  $\frac{1}{2}$  inch in diameter and acrylic resin plates  $\frac{3}{16}$  inch thick (Fig. 8) were used in some experiments to back up the thin lateral upper

region was distributed over a larger area by inert substances, such as stainless steel washers or the acrylic resin plates as shown in Figure 8. Reference to Table 1 shows these increased values.

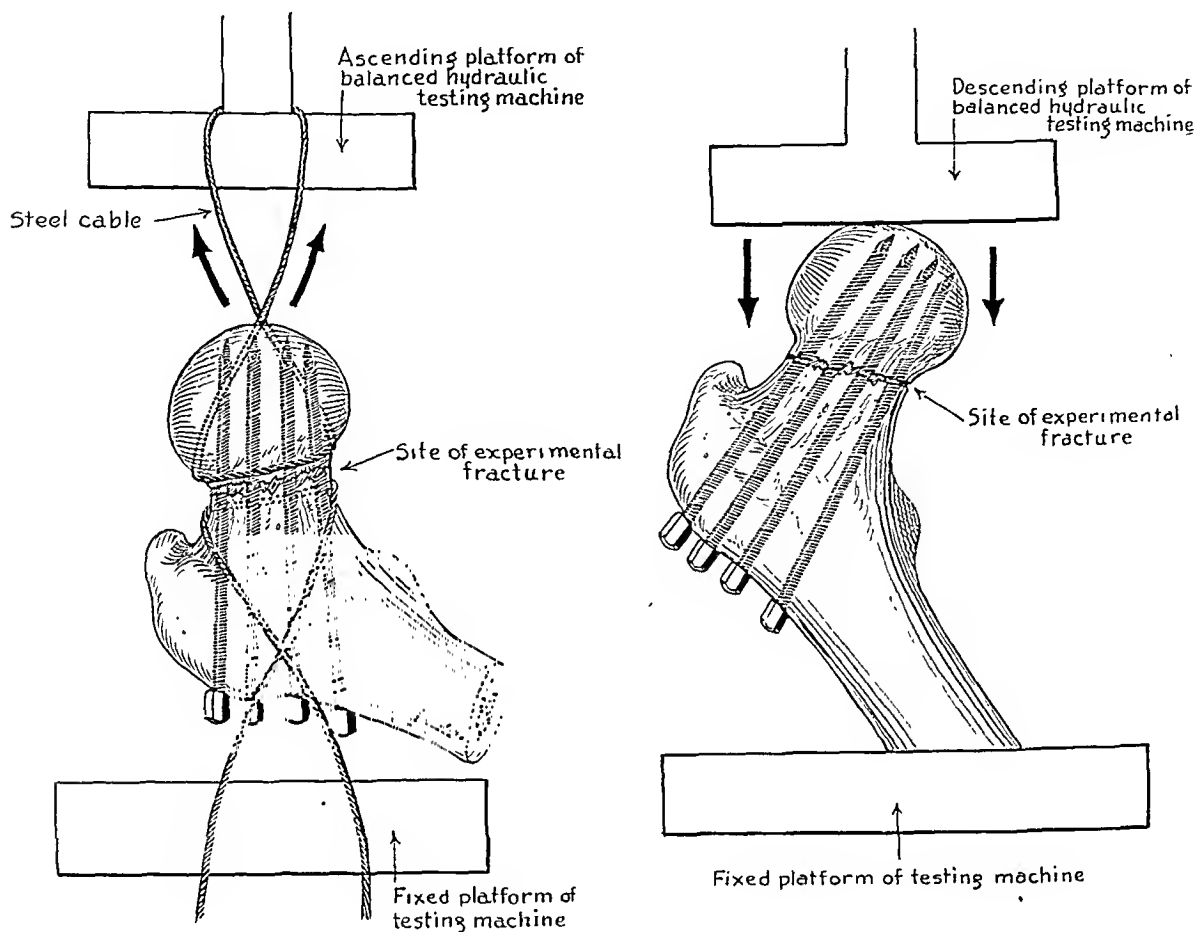


FIG. 3. Diagram showing the mounting of specimens for determination of the force required to distract experimentally produced transcervical fractures. Note that separation can occur by either pulling the head from the fixation device or by the fixation device holding in the head and pulling through the lateral trochanteric shell. FIG. 4. Diagram of the positioning of specimens for determination of superior-inferior crushing force.

femoral cortex above and immediately below the vastus externus line.

A classifying list of the representative types of fixation materials whose holding power was tested is given in Table II. It should be recalled that Vitallium is a cast alloy and is softer and more brittle than surgical stainless steel. After a few tests it became evident that when the screw type fixation materials were used, better impaction was secured in experimental fractures and consequently higher holding power values when the counter pressure against the lateral femoral cortex in the trochanteric

#### OBSERVATIONS AND RESULTS OF TESTS

The observations made on the experimental specimens during the introduction of fixation materials and later as they were tested are of importance equal to the numerical force values taken at the breakdown of the specimens. When a smooth surfaced type of fixation material, such as the tri-bladed nail, the Cubbins-Callahan-Scuderi flange, the Z-nail or Steinmann pins, was introduced, a certain amount of manual pressure was required to keep the central fragment from being driven

TABLE I  
SUMMARY OF DISTRACTION AND CRUSHING TESTS OF FIXATION MATERIALS IN EXPERIMENTAL  
TRANSCERVICAL FRACTURES

Type of Fixation Material	Distraction Tests			Crushing Tests			Remarks on Tests
	No.	Median (lb.)	Maximum (lb.)	No.	Median (lb.)	Maximum (lb.)	
Smith-Petersen tri-bladed nail	6	170	300	11	800	1110	Nail cuts cancellous bone; sometimes bends on crushing
Cubbins-Callahan-Scuderi flange.....	4	170	150	13	490	800	Nail cuts cancellous bone
Thompson Z-nail.....	2	50	50	4	400	470	Nail bends on crushing
3 Steinmann pins..... ( $\frac{5}{32}$ inch diameter)	4	30	30	8	750	1080	Pins usually cut upper shaft cortex on crushing
4 Moore pins (parallel)...	4	70	130	6	540	700	Pins bent upon crushing
2 Geckler screws.....	6 6 (washers)	540 830	1100	8	530	1960	Pins bend often on crushing but cut bone on soft specimens
Moreira lag screw.....	5	200	345	4	600	720	Pulls out core of bone; shaft of device bends on crush test
Lorenzo screw.....	5	320	340	5	700	770	Cortex on shaft side pulls out unless placed low; screw cuts head on crush
Lippmann corkscrew bolt.	3 3 (washers)	320 550	1010	6	620	700	Holding power increased by adding washers to buttress lateral cortex
2 large Vitallium wood screws	4	260	270	6	500	850	Screw brittle; shaft breaks on crushing
3 capped stainless steel screws (0.125 inch diameter)	16 4 (washers) or plates)	330 580	990	8	640	1450	Washers or plastic plates improve resistance of lateral femoral cortex and raise resistance to distraction; on crush shaft of screws cuts cancellous bone of neck and head
4 capped stainless steel screws (0.125 inch diameter)	12 8 (washers or plates)	590 840	1190	10	600	1650	
5 capped stainless steel screws (0.125 inch diameter)	12 2 (plates)	600 990	1550	10	800	1200	
3 larger stainless steel screws (0.156 inch diameter)	8	250	540	6	460	720	
5 Compere threaded wires (0.080 inch diameter)	8	280	380	15	360	710	
Unfractured controls.....	14	710	1240	19	2550	4050	

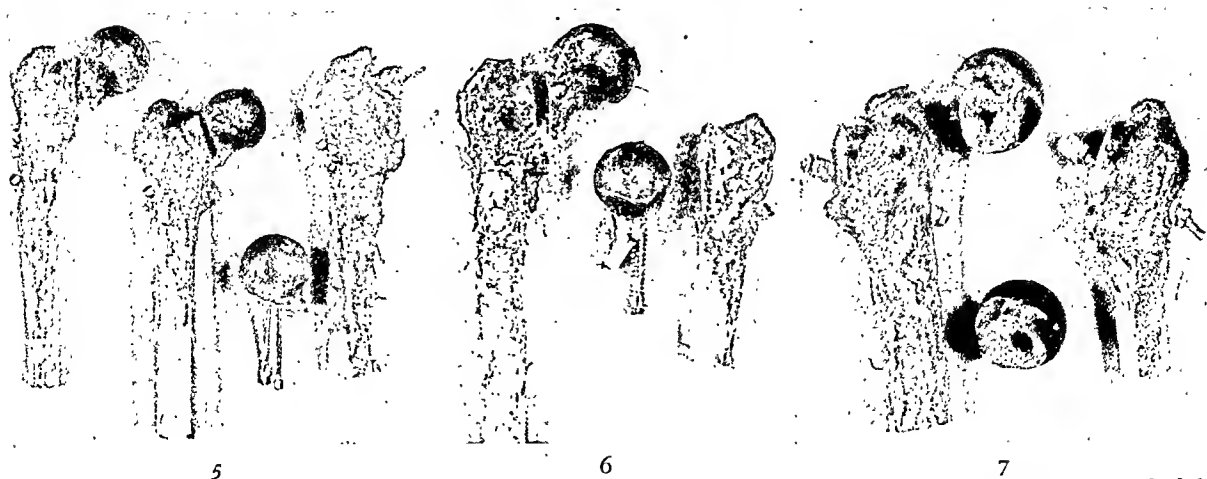


FIG. 5. Specimens from three experiments of the determination of distracting force. In the two specimens on the left the femoral head was pulled from the screws and all the screws held in the proximal fragment, because most of the screws were inserted low enough on the lateral femoral cortex to take advantage of thick cortical bone. In the specimen on the right two of the screws held in the head and the screw heads pulled through the lateral cortex and trochanter.

FIG. 6. Anteroposterior and lateral views of two specimens in the distraction experiment utilizing the Lorenzo screw. The screw was removed from the specimen on the left prior to photography, but in both instances the screw held in the central fragment and pulled through the lateral femoral cortex.

FIG. 7. Specimens from two distraction experiments utilizing the Moreira lag screw. Note that the hold on the femoral head was secured by cancellous bone between the screw threads. When distraction occurred, the device retained a core of cancellous bone and the femoral head pulled free. The device held in the distal fragment because of the distribution of stress over an area of the lateral cortex by a curved plate.

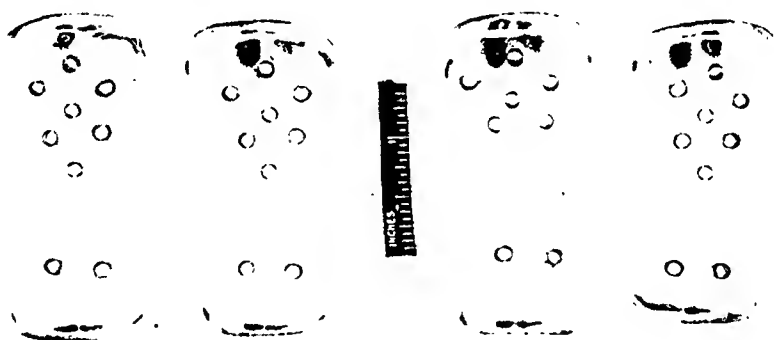


FIG. 8. Small  $\frac{3}{16}$  inch thick acrylic resin plates used to buttress the lateral cortex of the upper femur.

away from the proximal one. This signifies trauma to the articular cartilage in patients. Obviously the introduction of such types of fixation takes place more readily in living bone than in the dead bone of the specimens. Any impaction at the fracture site was the sole result of mechanical impaction imparted in a central direction to the trochanteric fragment, signifying additional trauma. No such tendencies of the central fragment to escape from the proximal fragment were noted when the screw types of fixation engaged the central fragment. In general, the smaller the diameter

of the screw the less motion was imparted to the central fragment. Deep introduction of all types of screws into the central fragment pulled this fragment toward the distal fragment irrespective of the presence or absence of threads on the portion of the device passing through the trochanteric area. In the instance of the Moore pins, which are smooth on the distal half, no such impaction with introduction was observed. When an initial gap of  $\frac{1}{4}$  to  $\frac{1}{2}$  inch was present at the fracture site, the gap was eliminated and the fracture surfaces became impacted as the screws were tightened.

When stainless steel washers or acrylic plates were used to buttress the lateral femoral cortex, powerful impaction was secured. This action was reflected in the regular 50 to 70 per cent increase in the values required for distraction in the tests.

It should be pointed out that the ability of a screw to engage the central fragment is in proportion to the total surface area introduced into the central fragment. Multiple slender screws with many turns to the inch afford more holding surface in proportion to bulk than do the lag screws. This fact was further borne out in the frequent observation in the distraction tests that the long slender hexagon headed screws would hold in the central fragment and the heads of the screws would pull through the upper lateral femoral cortex and the trochanteric region (Fig. 5) when distracted while the femoral head would be pulled free from the lag screws with a core of cancellous bone remaining between the threads. (Fig. 7.) This latter observation differed in some tests depending upon the amount of counter pressure distributed over the lateral femoral cortex. As a result the Moreira lag screw, which is equipped with a Vitallium plate against which the outer screw is tightened, (Fig. 7) illustrates the first situation while the illustration of Figure 6 (Lorenzo screw) was an instance when the butt of the screw pulled through the lateral femoral cortex as forcible distraction occurred. The Lippmann Vitallium cork screw bolt invariably pulled through the lateral femur until the washer was used to buttress this region. (Table 1.)

The numerical values of forces required for distraction (Table 1) were lowest when the smooth-surfaced devices were under consideration. The five devices listed first in Table 1 were the least satisfactory in the distraction tests. The screw types of fixation regularly demonstrated two to three times the holding power of the five first mentioned devices, and the holding power increased with the number of screws used and became 45 to 75 per cent greater when the lateral cortex was buttressed with stainless steel washers or acrylic plate. The highest values were secured with the Geckler screws and four and five hexagonal headed slender stainless steel screws. It should be pointed out that the maximum values obtained with these devices exceeded the

maximum force required to pull the femoral head from an unfractured specimen.

All the devices tested regardless of their architecture showed up well in the crushing test to a superior-inferior force. Comparisons should not be closely drawn between the

TABLE II  
CLASSIFICATION OF MATERIALS USED FOR FIXATION OF  
FEMORAL NECK FRACTURES BASED ON RESISTANCE  
TO TESTS\*

Little Resistance to Distraction; Good Holding on Crush
Smooth surfaced Vitallium appliances
Smith-Petersen nail
Smooth surfaced stainless steel appliances
Cubbins-Callahan-Seuderer flange
Stainless steel Smith-Petersen nail
Neufeld nail
Thompson Z-nail
Good Resistance to Distraction; Good Holding on Crush
Vitallium screw appliances
Godoy-Moreira lag screw (stud-bolt)
Lippmann corkscrew bolt
Venable type large Vitallium wood screws
Large stainless steel screws
Lorenzo lag screw
Smooth pins offering little resistance to distraction
Multiple Steinmann pins
Moore pins
Rigid on fixation by threaded pins and slender screws
Compere threaded wires (0.080 inch in diameter)
Geckler screws
Harmon slender threaded hexagon headed stainless steel screws

\* Washers or other buttress material improve strength of upper lateral femoral cortex.

different types of devices since the nails, flanges, Steinmann pins and slender stainless steel screws cut the cancellous bone of the head and neck before the fixation device bent. When the flat surface of the Thompson Z-nail was oriented toward the crushing force, this type of fixation was observed to bend before cutting the cancellous bone. This same observation was also made with Moore pins, occasionally with Geckler screws and on the shaft of the Moreira lag screw. In the instance of the large Venable type wood screws the screws themselves often fractured transversely. The devices which showed up best in the crushing tests were the Smith-Petersen tri-bladed nail, three  $\frac{5}{32}$  inch Steinmann pins, all the lag screws and all the slender screws. The resistance to crush in none of the experimental specimens even approximated the force required to fracture an intact preparation without fixation (note the values obtained in Table 1 with unfractured controls).



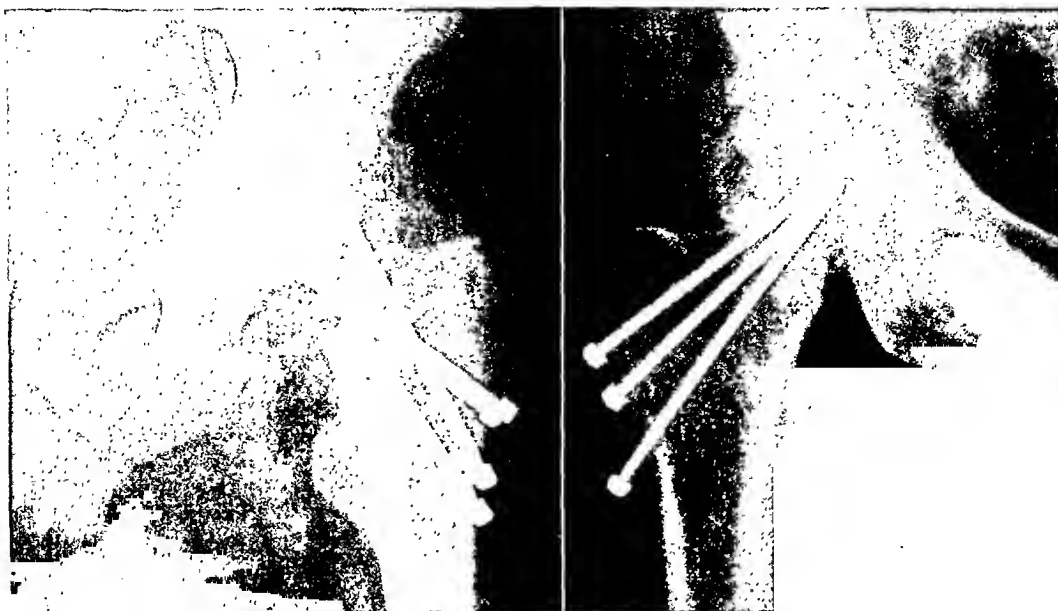


FIG. 9. Anteroposterior and lateral roentgenograms taken immediately after fixation secured by four long slender hexagonal-headed screws. Note that the fracture line is difficult to see as the result of impaction by the screws.

FIG. 10. Anteroposterior roentgenograms of a case of a near horizontal fracture line in which impaction and even better position was secured by preliminary overtraction, slight medial displacement of the distal fragment and impaction of the distal fragment into the central fragment by screws. Weight-bearing was begun by this patient at eight weeks and crutches were discarded at twelve weeks.

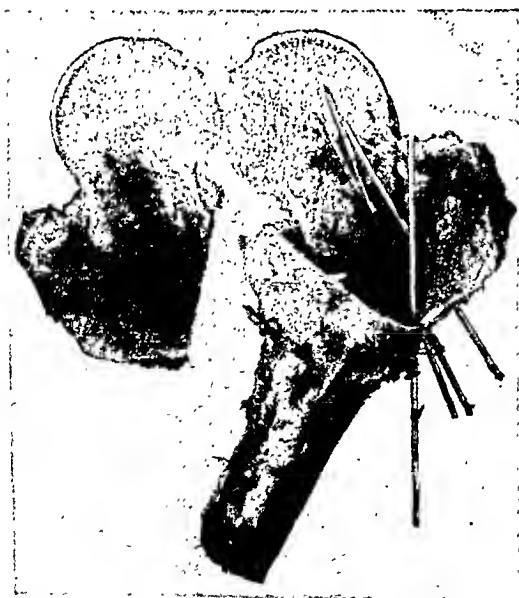


FIG. 11. Photograph of a postmortem specimen nine months after screw fixation of a fracture at the base of the neck in a patient with roentgen necrosis of the femoral head. Prior to sectioning the specimen the screws had been withdrawn, their heads removed and then partially reinserted. The specimen demonstrates substitution of most of the lateral half of the central fragment. There was clinical healing of this fracture.

#### APPLICATIONS OF EXPERIMENTAL OBSERVATIONS TO TREATMENT OF TRANSCERVICAL FRACTURES IN MAN

The experiments described in this paper were carried out after the long slender threaded hexagon headed screws had been used for some years in the treatment of transcervical fractures in man. In a previous report (1945) of results in thirty-five cases in which this type of fixation was used satisfactory union with a viable head was secured in thirty-one cases, or 88.6 per cent. There was no necrosis of the femoral head, a fact which was attributed to the institution of traction-reduction on the same day of the fracture in thirty-three of thirty-five cases. Trochanteric osteotomy was judged necessary in three cases of delayed union with vertical or near-vertical fracture lines. A frank case of non-union occurred in one patient who was in a precarious state of health, blind and bedridden. The cause of the non-union was an unsatisfactory reduction which persisted after different attempts to better the position. Since publication of the former report, similar statistics are available on eighteen additional cases. There have been no non-

unions and no necrosis of the femoral head except in a single case in which three pins fractured under unusual circumstances in a thirty-three year old patient who subjected this region of the anatomy to unreasonable and undue stress too soon after operation and against the advice of the surgeon. Figures 9 and 10 are roentgenograms of representative cases in which this type of fixation was used. Figure 11 is a photograph of a specimen in which these types of screws were used in a patient suffering from roentgen necrosis and transcervical fracture. Partial substitution was observed during the lifetime of this patient. The full technic which was used by the authors was described in the previous publication (1945) and will not be repeated here. It should be pointed out that traction-reduction, introduction of fixation with minimal moving of the patient prior to fixation and two to three months' partial bed rest are considered to be just as important, or more important, than the type of fixation used. No patient was allowed to bear weight on the fractured extremity even with the aid of crutches until six to ten weeks after reduction and fixation of the fracture. This period is determined from roentgenograms made at six weeks.

#### SUMMARY AND CONCLUSIONS

The holding power to distracting and crushing forces was estimated for twelve types of internal fixation materials that are commonly used in the treatment of transcervical fractures of the femur in man. These twelve types of materials were selected for testing in experimentally produced transcervical fractures in cadaver specimens because they were representative of the entire group of metallic internal fixation devices used in these fractures. The numerical values obtained in 242 tests are given and the observations made during this work are described. Included in the devices are multibladed nails, steel flanges, Steinmann pins, special slender pins and screws and various types of lag screws.

Fractures immobilized by the hexagon headed slender stainless steel screws yielded the highest values on resistance to both distraction and crushing. The holding power of these screws against a distracting force was increased 45 to 75 per cent by buttressing the trochanteric and upper lateral femoral cortex with stainless steel washers and plastic plates.

These values even exceeded the force required to pull the femoral head from an unfractured specimen.

All the devices tested showed up well on crushing. Especially high values were observed in the tests for the Smith-Petersen tri-bladed nail, several Steinmann pins ( $\frac{3}{32}$  inch in diameter), the various lag screws and multiple long slender hexagon headed screws.

The results are given in fifty-three cases of transcervical fracture in man treated by early reduction and a precise regimen in which the long slender hexagon headed screws were used for fixation. Direct union without other procedures was observed in forty-five of fifty-three cases (84.9 per cent). Trochanteric osteotomy within six months after fracture was performed on the surgeon's judgment in six cases in which union was observed not to occur promptly. The two instances of non-union were observed to follow reduction failure in one instance and to fracture of the screws in an unreasonable and hyperactive patient. There were no instances of necrosis of the femoral head. The minimum follow-up period was one year and several patients were followed for six years.

The long slender hexagon headed screws serve as their own guide or pilot pins. They are introduced atraumatically with a drill and can be withdrawn and reinserted easily and without damage to the bone. The depth of insertion can also be adjusted after control roentgenograms.

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# END RESULTS IN SEVENTY-SEVEN CONSECUTIVE FRESH FRACTURES OF THE NECK OF THE FEMUR\*

JOHN T. F. GALLAGHER, M.D.

*Madison, Wisconsin*

**S**TIMULATED by the excellent and frank report on the pitfalls in management of fractures of the neck of the femur which contribute to non-union by Siris and Mulholland<sup>1</sup> at last year's meeting of this association, and echoes of Speed's oration<sup>2</sup> on the "unsolved fracture" ringing in our ears much clearer than at the time of its delivery in 1935, we decided to examine our own end results more thoroughly. One of us had the temerity to report the "solution of the unsolved fracture"<sup>3</sup> based on two factors, namely, an accurate reduction with internal fixation and a special protractor with which to do it. We now retract the protractor.

The following is a review of seventy-seven consecutive fresh fractures of the neck of the femur treated at the Jackson clinic between the years 1936 to 1946, inclusive.

In this series thirteen, or 17 per cent, were under sixty years of age; eighteen, or 23 per cent, between sixty and seventy years; forty-five, or 59 per cent, between seventy and ninety years and one over ninety years old. Nine, or 12 per cent, were males while sixty-eight, or 88 per cent, were females. Twenty-two, or approximately 30 per cent of the patients had impacted fractures and all made uneventful recoveries except one who was submitted to internal fixation and subsequently developed absorption at the fracture site and aseptic necrosis of the head. On checking the films taken at operation it was found that the impaction had been broken up by the insertion of the nail and had not been sufficiently corrected. There were nine patients in the impacted group who showed moderate degenerative arthritic changes, six with coxa vera, but all had good functional results with full weight-bearing. There were three deaths in this group from two to nine years following injury.

The treatment of those with impactions was conservative, consisting of bed rest, light Russell's traction, 4 to 5 pounds, or balanced

traction suspension with a Thomas splint and Pierson attachment for one month to six weeks, then a wheel chair and partial weight-bearing with crutches and full weight-bearing at three to six months. No disrupted impactions or other complications developed during hospitalization, largely due to excellent nursing care. Patients received frequent change of position, checking of suspension apparatus and, most important of all, active muscle exercises from the start. Weekly or biweekly X-ray checks, anteroposterior and lateral, were made, or whenever the occasion demanded.

Of the fifty-five displaced fractures of the neck, subcapital, transcervical and basal, fifty-two were treated by internal fixation with the Smith-Petersen three flanged nail under spinal anesthesia. The three patients not operated upon died twenty-four hours, forty-eight hours and one week after injury from uremia, multiple injuries following an automobile accident, and parkinsonism with pneumonia, respectively.

One case is considered a true operative mortality, a sixty-seven year old female with pernicious anemia died seven days post-operatively of uremia. All other deaths during the period of this survey occurred from three months to nine years postoperatively. The overall mortality in the displaced group numbered twenty-two or 40 per cent.

The technic of preparation, reduction and fixation by "blind nailing" has been described elsewhere by Jackson.<sup>3</sup> The only deviation being that during the period of 1940 to 1943 the Cubbins-Callahan-Scuderi<sup>4</sup> approach was used in nine cases, in one of which a portion of the anterior capsule was found to lie between the fragments preventing an accurate reduction preoperatively.

The principles generally adhered to were: (1) Anteroposterior and lateral X-ray examinations on admission; (2) immediate traction; (3) evaluation of physical condition with sup-

\* From the Jackson Clinic, Madison, Wis.

portive therapy; (4) accurate reduction using modified Leadbetter technic; (5) lateral nailing with Smith-Petersen nail; (6) impaction; (7) light traction for one week; (8) early ambulation and discharge from the hospital in three weeks using crutches; (9) discard crutches at three months; (10) follow-up X-rays at three to four-month intervals for two years.

There is no doubt that these patients seemed to do better initially than some of those with impacted fractures. Their morale was high, their hospital stay was shortened and the financial burden was lightened. Initially, we were relying on the nail to do the trick, but we were enjoying a false security. In this group there were six non-unions, or 11.5 per cent, twenty-eight, or 53.8 per cent, showed aseptic necrosis and thirty-five, or 67.3 per cent, of these patients had degenerative arthritic changes of various degrees, characterized on X-ray by lippling, diminution of joint space, coarseness of trabeculations, thinning and eburnation of the articular cortices. Every case in this series of aseptic necrosis was accompanied by degenerative arthritic changes from moderate to severe degree. It is difficult to tell how much of the hypertrophic or posttraumatic arthritic changes are the direct result of trauma as the majority of patients in this advanced age group usually have modifications of these changes.

The nails were removed in eighteen cases at various intervals after one year when aseptic necrosis had occurred; in ten cases the nail was loose and partially extruded and the cannulated portion filled with necrotic debris on microscopic examination. Cultures of these specimens were negative except for a growth of streptococcus viridans on one and staphylococcus aureus in two which was reported as a contamination. In one case the nail had bent in the middle 15 degrees; union subsequently occurred with moderate coxa vera. A similar 9 cm. nail was tested and it was found to require 575 pounds to bend it grasping it 1 inch from either end with the blade pointing vertically while only 345 pounds with the blades flat, a fact that might be considered in placement of the nail at operation.

Two proximal femoral specimens were obtained at six months postoperatively: one from a patient who had just left the office walking with a cane and who was killed in an automobile accident and the other from a bedridden

decompensated cardiac. Both of these specimens seemed solid when removed, and X-rays were interpreted as showing some evidence of union but microscopic examination at the fracture site revealed only fibrous union.

The following is a case report illustrating rapid disintegration of the proximal fragment following good reduction and fixation but too early and strenuous weight-bearing in an otherwise healthy active farmer.

#### CASE REPORT

K. V. P., 65-455 AET. 57, was injured February 27, 1942, when an end gate of a truck struck his right hip knocking him to the ground. He was unable to get up. The patient was admitted to the hospital immediately with external rotation and shortening of the right leg.

X-rays showed a displaced transcervical fracture of the right femur. The leg was placed in 4 pounds Russell's traction and six days later Smith-Petersen nailing with Callahan-Seuderer approach was performed. A portion of the anterior capsule was interposed preventing accurate reduction preoperatively.

The postoperative course was uneventful. He was up in a chair in two days, was discharged from the hospital on March 20, 1942, or sixteen days postoperatively. He used a crutch but was permitted no weight-bearing and at two months he was using a crutch with light weight-bearing permitted. At six months he was bearing full weight and doing light farm work; and at one year he was doing heavy farm work. At sixteen months he was doing heavy farm work but he complained of pain in the right hip. X-ray showed aseptic necrosis and the patient was advised to have the nail removed.

I did not see him again until August, 1946, at which time there was severe necrosis of the head with degenerative arthritic changes; a reconstruction operation was advised but was refused.

#### CONCLUSION

The incidence of aseptic necrosis and degenerative arthritic changes is alarmingly high in this series.

A review of the progress of these patients reveals two factors that we believe contribute to these complications: (1) Too early weight-bearing and (2) internal fixation by lateral nailing adds a certain amount of damage to the already greatly impaired circulation.

We have not performed primary osteotomy with the greater assurance of union and reasonably good function, believing that the

immediate disadvantage of greater postoperative mortality and discomfort outweighs the advantages. We believe that the Smith-Petersen nail has stood the test of time for fixation *per se* and perhaps with the addition of a cancellous bone graft or some other means of promoting osteogenesis as well as a more careful follow-up and delay in full weight-bearing for a year or so, a more satisfactory compromise can be made to the satisfaction and comfort of the patient in this most difficult of all fractures.

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# INTRACAPSULAR FRACTURES OF THE NECK OF THE FEMUR\*

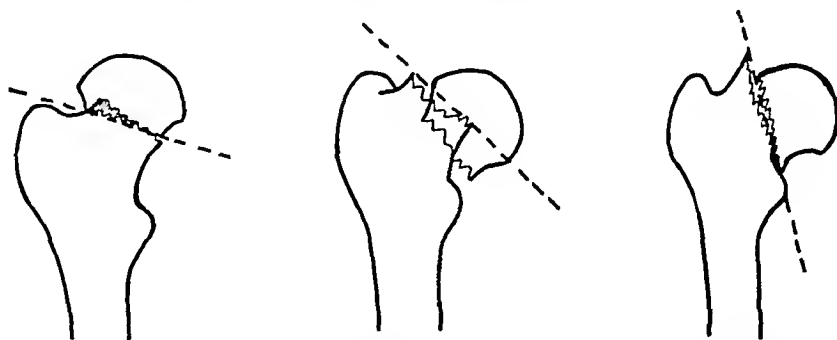
FOLLOW-UP REPORT OF 130 PATIENTS TREATED BY INTERNAL FIXATION WITH THE  
SMITH-PETERSEN NAIL

CHARLES S. NEER, M.D. AND HARRISON L. McLAUGHLIN, M.D.

*New York, New York*

THIS report presents some observations resulting from the critical appraisal of 130 consecutive intracapsular hip frac-

During the period covered by the study 255 hip fractures of all types were treated. True intracapsular lesions, therefore, compromised



Type I

Type II

Type III

FIG. 1. Pauwels' classification, 1935. Type I, valgus; type II, mid-neck; type III, oblique subcapital.

tures treated at the Fracture Service of the Presbyterian Hospital in New York between 1932 and 1944. A Smith-Petersen nail was used

about 50 per cent of the total. Table I depicts the relative incidence and average age of the various categories described by Pauwels. These

TABLE I  
CLASSIFICATION OF INTRACAPSULAR FRACTURES

	130 Intra- capsular, Per Cent	255 Total Hip Frac- tures, Per Cent	Average Age
26 Valgus.....	20	10	59
57 Mid-neck.....	44	22	66
47 Subcapital.....	36	18	66

for fixation in each case. All fractures of more than two weeks' duration and all trochanteric and base of neck lesions were excluded from the study so that the remarks to follow pertain solely to true, early intracapsular fractures. These will be segregated into three categories according to the classification described by Pauwels,<sup>1</sup> (Fig. 1.)

TABLE II

MEDICAL HISTORY—130 CASES

Over 79 years of age.....	15
Hemiplegia.....	6
Other fractures.....	5
Cardiac failure.....	5
Senile dementia (severe).....	4
Other psychoses.....	2
Pyelitis.....	2
Rheumatoid arthritis.....	3
Malignancy.....	3
Parkinsonism.....	2
Diabetes.....	3
Bronehopneumonia.....	3
Cataracts.....	1
Burns.....	1
Tabes.....	1

56

patients were unselected. Fifty-six, or 43 per cent suffered from important systemic conditions requiring correction prior to or control coincident with active treatment of the frac-

\* From the Department of Orthopedic Surgery, College of Physicians and Surgeons, Columbia University, and the Fracture Service, Presbyterian-New York Orthopedic Hospitals, New York, N. Y.

ture. Some of the more significant of these complicating problems are listed in Table II.

#### MANAGEMENT

All but 13 (10 per cent) of the patients were admitted within forty-eight hours of injury.

TABLE III  
OPERATIVE MANAGEMENT OF INTRACAPSULAR FRACTURES  
FIXED WITH SMITH-PETERSEN NAIL

	No Reduction	Closed	Open
26 Valgus.....	26	0	0
57 Mid-neck.....	0	24	33
47 Subcapital.....	0	7	40
	26	31	73

It was usually possible, therefore, to carry out immediate evaluation and treatment of the patient coincident with fixation of the fracture. Every hip fracture was considered an acute emergency demanding early treatment designed to minimize the period of pain and bed stay. Eighty per cent of the patients were operated upon within six hours of admission. In the presence of any systemic condition which increased the normal operative risk measures were taken immediately for its control or correction, e.g., a patient in fibrillation was digitalized as rapidly as possible and operation was usually done within six to eight hours. Otherwise, operation was usually performed within one to two hours.

Impacted valgus lesions were nailed without reduction or visualization of the fracture. All displaced fractures were reduced prior to fixation. Reduction was carried out under direct vision in seventy-three cases and under roentgenographic control in thirty-one cases. (Table III.) Subcapital oblique fractures proved the most difficult to reduce and frequently could not be reduced adequately by manipulation alone. Following operation, 65 per cent of all patients were allowed out of bed within twenty-four hours. Those physically able to use crutches commenced ambulation without weight-bearing in a walker about the fourth postoperative day and were promoted to crutches as rapidly as tolerated. (Table III.)

#### MORBIDITY AND MORTALITY

Morbidity cannot be described by measurable standards. However, it was observed in November, 1948

the cases under discussion that the morbidity constantly diminished in direct proportion to the speed and efficiency with which stabilization of the fracture was carried out. The mortality, Table IV, has been divided into three categories: "Operative mortality" includes

TABLE IV  
MORTALITY

	No Reduction	Closed	Open	Total Per Cent
Operative.....	0	1	1	2 (1.5)
Related.....	0	0	2	2 (1.5)
Unrelated.....	1	2	5	8 (6.2)
No. of cases.....	26	31	73	130

deaths from any cause during the first thirty days following operation, e.g., one patient expired from pulmonary embolism twenty-eight minutes after completion of open reduction and another patient on whom a closed reduction and lateral nailing was carried out without adequate preoperative digitalization died in cardiac failure on the fourth day following operation. "Mortality related to injury" includes deaths related to the injury occurring within nine months of operation, e.g., one death at four months from pulmonary infarction secondary to thrombophlebitis and one at seven months due to infection of the hip and pneumonia. "Mortality unrelated to injury" includes all deaths from unrelated causes between the end of the first and ninth months, e.g., three cardiac infarctions, two cerebral accidents, one malignancy, one renal failure and one suicide. (Table IV.)

#### RESULTS

The incidence of bony union and subsequent avascular necrosis of the femoral head must constitute two of the more important features of any study of fractured hips. Identification of the former by adequate roentgenography should be definite. Aseptic necrosis, on the other hand, depends upon relative changes and is much more difficult to evaluate. A definition of terminology, therefore, is in order. Figure 2 illustrates the arbitrary distinction used in this study to differentiate between what will be termed "mild" and "severe" aseptic necrosis. Mild necrosis indicates avascular changes affecting only the roentgen texture of the



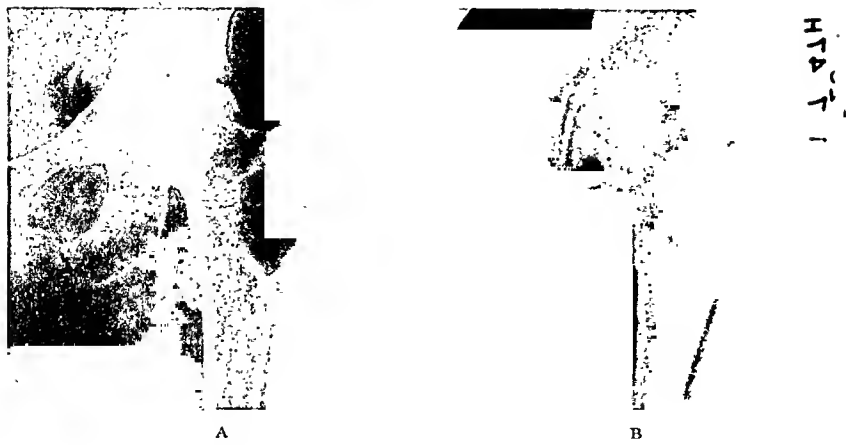


FIG. 2. Aseptic necrosis; A, mild; B, severe.

femoral head. Severe necrosis indicates changes pronounced enough to change the shape or contour of the femoral head. The additional term "arthritic change" tends to confuse the issue and will be omitted. Many conditions described in other reports under the term arthritic change undoubtedly would fall into the category to be termed mild aseptic necrosis.

IMPACTED VALGUS FRACTURES

*Early Complications.* The twenty-six impacted valgus fractures presented no difficult

TABLE V  
EARLY COMPLICATIONS—TWENTY-SIX VALGUS CASES

Mortality.....	0
Wound infection.....	0
Nail intrusion.....	3 (11%)
Hospital stay (average).....	14 days
Weight-bearing (average).....	5 months

TABLE VI  
LATE COMPLICATIONS—TWENTY-SIX VALGUS CASES

	Per Cent
Adequate follow-up.....	23 (92)
Non-union.....	0
Mild necrosis.....	3 (11)
Severe necrosis.....	1 (3)

therapeutic problems. (Table v.) The morbidity was mild. The average hospital stay was only fourteen days.

*Late Complications.* All twenty-six cases healed by bony union; however, contrary to popular belief, aseptic necrosis was not absent and occurred in 14 per cent of these patients. Three showed mild avascular changes and one developed severe aseptic necrosis. (Table vi.)

DISPLACED INTRACAPSULAR FRACTURES

The operative mortality in 104 displaced fractures was 1.3 per cent in seventy-three

cases treated by open reduction and 3.2 per cent in thirty-one cases treated by closed reduction and lateral nailing. The operators consisted of all members of the staff from the most experienced attending to the least experienced resident surgeon. The duration of the operative procedures, therefore, varied considerably. However, closed reduction and lateral nailing constantly required more time than open reduction and nailing under direct vision. (Table vii.) It was also a constant observation that (1) regardless of the char-

TABLE VII  
OPERATIVE TIME AND MORTALITY

	Operative Mortality, Per Cent	Time (Anesthesia to Skin Closure)
73 Open reduction...	1 (1.3)*	1 hour, 53 minutes
31 Closed reduction..	1 (3.2)†	2 hours, 19 minutes
104 cases.....	2 (1.9)	

\* Embolus.  
† Cardiac (not digitalized).

acteristics of the fracture, reduction and fixation were accomplished more certainly and accurately when carried out under direct vision and (2) this unselected group of patients withstood the effects of open reduction as well if not better than manipulative reduction and blind nailing.

*Early Complications.* The oblique subcapital fracture with a vertical fracture line deserves recognition as a complication in its own right.

Its presence made both reduction and fixation more difficult than in any other type of hip fracture. Because of this, it has become our policy of operative technic to modify such a lesion so that the line of fracture would approach the horizontal plane. When neces-

were possible in seventy-four (71 per cent) of the 104 displaced fractures. (Table x.)

Table xi includes only those patients with bony union and an adequate follow-up. Forty-two per cent of healed fractures treated by open reduction and 54 per cent of those

TABLE VIII  
EARLY COMPLICATIONS—104 DISPLACED CASES

	73 Open, Per Cent	31 Closed, Per Cent
Subcapital fracture.....	40 (55)	7 (22)
Poor reduction.....	11 (15)	14 (45)
Infection—serious.....	1	0
—trivial.....	6 (8)	3 (10)
Loss of fixation.....	11 (15)	2 (7)

sary, this was done by primary cervical or trochanteric osteotomy. In addition, many apparently satisfactory reductions by x-ray<sup>2</sup> proved inadequate on visual inspection of the fracture line. Consequently, arthrotomy was found to be essential for optimum reduction and stabilization of almost all subcapital fractures. There was little or no difference between open and closed reductions in the incidence or effect of postoperative infections. During convalescence 12.5 per cent of 104 displaced fractures were complicated by loss of fixation. Almost invariably this complication resulted from faulty technic of nail insertion or reduction, and frequently both. (Table viii.)

*Non-union.* Poor reduction or fixation also accounted for the great majority of non-unions. (Table ix.) However, improper placement of the nail resulted in disaster for three well reduced cases. Early severe aseptic necrosis, prior to bony union occurred only once, suggesting failure of local blood supply to be a relatively unimportant cause of non-union when compared to inadequate restoration of anatomy. Two uncooperative patients were considered to have contributed to their non-unions by early and strenuous unauthorized weight-bearing on the injured leg.

*Avascular Necrosis of the Femoral Head.* The interval between operation and the first evidences of aseptic necrosis has resulted in the adoption of eighteen months as the minimum adequate follow-up period. Periodic clinical and roentgen examinations for at least this period

TABLE IX  
CAUSE OF NON-UNIONS—104 DISPLACED FRACTURES

	73 Open (55% sub- capital)	31 Closed (22% sub- capital)
Poor reduction.....	11	4
Poor fixation.....	2	1
Failure of circulation?.....	1	0
Walked too soon.....	2	0
	16	5

Note: 72 per cent non-unions were in subcapital fractures.

treated by closed reduction and lateral nailing subsequently went on to show aseptic necrosis of the femoral head. The first evidences of all severe avascular lesions were apparent within nine months of operation. The first evidences of mild lesions often did not occur until after

TABLE X  
FOLLOW-UP

	73 Open	31 Closed
1.5 to 3 yr.....	21	5
3 to 5 yr.....	16	5
5 to 8 yr.....	9	5
8 to 12 yr.....	8	5
	54 (74%)	20 (65%)

one year. Twenty-six months was the longest and eleven months the average interval between operation and demonstrable early avascular changes. It is worthy of note that in spite of the much higher proportion of subcapital fractures in the open reduction group, (Table viii) the incidence of aseptic necrosis in this group remained consistently less than in the simpler cases treated by closed reduction. This finding contradicts the widespread impression that open reduction contributes to avascular necrosis subsequent to fracture of the femoral neck.<sup>3,4</sup>

## MUSCLE TRANSPLANT SERIES

Between the years 1933 and 1937, eighteen intracapsular hip fractures were subjected to open reduction and coincidentally a flap of rectus femoris or vastus lateralis muscle was inserted into a decorticated area on the anterior

TABLE XI  
NECROSIS FOLLOWING UNION  
18 MONTHS OR MORE FOLLOW-UP

	Mild, Per Cent	Severe, Per Cent
Open reduction—38 cases.....	9 (24)	7 (18)
Closed reduction—15 cases. ....	4 (27)	4 (27)

surface of the head and neck of the femur. It was hoped that this might increase the local blood supply to the head fragment.<sup>5</sup> Thirteen cases in this series were suitable for analysis. (Table xii.) Their results warranted little optimism that the procedure was of any help

TABLE XII  
THIRTEEN MUSCLE TRANSPLANT CASES

Mortality.....	0
Infection.....	0
Nonunion.....	3 (23%)
Necrosis following union—mild. 2 (20%)	
—severe.....	0

in preventing aseptic necrosis or of any aid in the healing of the fracture.

## EVALUATION

The preceding discussion has been restricted to an objective study of a group of patients

TABLE XIII  
SUMMARY OF RESULTS

	73 Open, Per Cent	31 Closed, Per Cent
Mortality { Operative.....	1.3	3.2
Related.....	2.6	0
Unrelated.....	6.8	6.5
Non-union.....	21.9	16.1
Aseptic necrosis.....	42.0	54.0

with fractured hips. The results, Table xiii, are discouraging and humbling from the viewpoint of the surgeon. Almost every poor surgical result was found to be due to some controllable defect in the technic of therapy. Consequently,

the percentage of good results was considerably less than should have been obtained. Realization of this fact during recent years has stimulated insistence upon perfection in each of the numerous finer details of technic. It seems reasonably certain that only by perfec-

TABLE XIV  
PATIENT'S EVALUATION VS. SURGEON'S EVALUATION

	73 Open, Per Cent	31 Closed, Per Cent
Patient satisfied.....	86	92
Surgeon satisfied.....	25	20

tion of technic can the incidence of non-union and aseptic necrosis be reduced to justifiable levels.

Patient reports on the results of hip fractures are misleading. The functional demand placed upon an extremity by a patient in this age group is usually small. Many such patients are satisfied with an unnecessarily poor surgical result. Table xiv indicates clearly that accurate evaluation can only be obtained by periodic clinical and roentgen examinations over a protracted period.

## CONCLUSIONS

1. The best time for reduction and fixation of a hip fracture is immediately.
2. Good treatment for impacted valgus fractures of the femoral neck is internal fixation and avoidance of bed stay.
3. Open reduction, properly done, is surer, shorter and no more dangerous than closed reduction and blind nailing.
4. Open reduction does not increase the incidence of subsequent aseptic necrosis.
5. Results are known only after objective evaluation.
6. Almost all of the bad results of hip nailing are still the results of bad hip nailing.

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DISCUSSION OF PAPERS BY DRS. HARMON, BAKER  
AND RENO, GALLAGHER AND NEER  
AND MCLAUGHLIN

KELLOGG SPEED (Chicago, Ill.): Honest observation and tabulation now show that nailing either by the so-called blind or open reduction method has an astounding percentage—not of non-union as it used to be called but now with effort at bony union and of the more advanced and scientific term of aseptic necrosis of the head from interfered with vascularity. The extremely oblique fractures of the neck are most difficult to reduce, to hold reduced and to obtain bony healing without separation of fragments or early aseptic necrosis. I have wondered for years just how important the terms intracapsular and extracapsular fracture were from a prognostic standpoint because we are shown in McLaughlin's series that open reduction of the fracture near the head finally give a lower percentage of aseptic necrosis when one might think that by open dissecting methods more blood supply to the already exsanguinated head would be lost.

The process might be summarized thus: The fracture is reduced and nailed properly with full attention to all technical details by earnest qualified surgeons; a certain and quite large percentage have suffered from interference with blood supply to the head which occurs at the instant of fracture. In addition there may be untoward trauma from the nail or screw insertion or the forceful impaction of the fragments after internal fixation as mentioned by Harmon. He found that the highest holding power of head to neck obtained by Geckler screws or hexagonal headed stainless steel screws was so powerful that the maximum holding power obtained exceeded the maximum force required to pull the head of the femur from an unfractured femur. This looks like real bony approximation and fixation which we know has its virtues in the bone healing after fracture but this also must be aided by physiologic rest. The accurate nailing and primary freedom from weight bearing give us some misleading roentgenograms. Rapidly occurring aseptic necrosis of the capital fragment is neither early nor quickly recognized. With a good reduction and freedom from weight bearing, replacement of bone in the head starts early and may progress favorably, again fooling us in the roentgenogram. Eventually comes the unlucky or unhappy day when weight bearing is permitted, often after full roentgenologic confirmation which

may be based on wrong interpretation. If the head has partially undergone Axhausen's creeping substitution, it may hold up for awhile but eventually begins to buckle with collapse of subcortical bone and finally cartilage warping and fragmentation although some cartilage may maintain nutrition for a long time from synovial fluid feeding. This becomes what we call clinically delayed or late aseptic necrosis but it probably is not any slower pathologic process at all than those which break down quickly, deform and cause disability because of too early weight bearing or unhappy axial replacement of fragments. The fracture of this rather soft and partly unsubstituted bone of the head after apparent bony healing with crushing of its cartilage is now advanced by Phemister as a second phase in untoward progress. Not only are six to nine months' time advisable for freedom from weight bearing to avoid this but in some instances two, three or more years are required. This leads us around in a circle again to the unsolved fracture. Must we treat a fracture of the neck of the femur even after accurate nailing with the most meticulous technic as we would a Legg-Perthes' disease in the adolescent, or should we devise some more searching view by the roentgenogram to enable us to distinguish aseptically necrotic bone quicker and better, or must we adopt some method of increasing or assuring a greater and more satisfactory blood supply to the poor capital fragment. You have heard the opinion of muscle flap transplantation advocated by Venable and Stuck. Many more instances of this procedure must be tried before final condemnation of its routine use but on the whole it does not sound physiologic. Muscle flap deprived partly of full and normal nerve and blood supply and physiologic use in the general direction of its fibers as intended naturally probably in a short time becomes a simple mass of fibrous tissue without much vascularity.

We must therefore study additional series of healed fractures at the neck of the femur treated by a meticulous technic of one method or another. Let us devise quicker and better methods of determination of aseptic necrosis of bone; let us revert to elementary principles in fracture treatment and use immobilization and freedom from strain of weight bearing and functional use until a natural healing or a natural replacement of devascularized and dead bone has occurred. Secondary and late so-called arthritis of the hip, reaction to a dead head with crumpled and undermined cartilage may then not develop in the hip joint as an irritant reaction.

The holding powers of the various types of metallic internal fixation agents are important only so far as they assure immobilization, absence of electrical and biochemical reaction and do not permit neck angulation nor interference with

creeping substitution in bone. I cannot see that removal of the fixative agent aids the final healing of the capital fragment fracture if the metal is inert biochemically. Reported series of bone transplants really show no better final results. Small chip or fragment onlay grafts onto the exposed neck may be biologically superior and lead to final bony substitution and restoration of a withstanding weight bearing upper end of the femur. If need be, they may be put in early at operative reduction to be followed by weeks of plaster immobilization. All these processes of repair require considerable time and some patients may succumb during the process.

RALPH G. CAROTHERS (Cincinnati, Ohio): I had not before considered the distracting force of any importance in these cases and it was interesting that Dr. Reno brought it out. However, I still believe it is not of so much importance. I noted in his pictures that his pins were put in so that they were not parallel; in other words, they crossed very much like the pictures of the original Moore articles. That will prevent distraction in itself, far better than a Smith Petersen nail, but the important thing to remember is that there is absorption of the neck in a great many of these cases and it is important that the outer fragment be permitted to slide in upon the inner fragment and maintain contact. Therefore, I believe the pins should be put in absolutely parallel or as nearly so as possible.

I have used the three pins rather than the Smith Petersen nail, but by putting them in parallel one simulates the three blades of the nail.

I think that in Dr. Gallagher's remarks about nailing causing a disruption of an already good impaction, that it does not hold if one uses these finer pointed pins rather than a larger Smith Petersen nail, and it has been my practice to nail these impacted fractures for the purpose of getting the patients out of bed and away from the hospital sooner.

Dr. Speed's remarks remind me of a case which occurred in our own family this last winter. An old lady had an intertrochanteric fracture of the neck of the femur which I elected not to pin but to put in traction. She obtained an excellent result and is now home and walking around quite well. It cost over \$6,000 for hospital and nurses. That is getting into figures that most people cannot afford, and even the government cannot keep us all too long. Therefore, something has to be done to get them going and quite early.

I am interested in how easy it seems to be to do the open reduction procedure. When Dr. Smith Petersen first presented this subject fifteen or more years ago, he performed a very large and glorious operation. I was impressed with the fact that 90 per cent of the patients I had could not have stood such an operation. Dr. Smith Peter-

sen's pictures were of fairly young, thin women who would walk up and down the steps to show how well they were afterward. My patients were old and feeble ladies and my nailing was on account of that. Now, apparently, we are going back to the other method, but I still have a large number of people who I do not believe could stand the open type of operation.

WALTER G. STUCK (San Antonio, Tex.): In most discussions of fractures of the hip there has been too much emphasis placed on getting the patients out of bed. These old women are not going anywhere. Many of them are feeble, most of them are glad to throw themselves on the mercy of their relatives and to get them out of bed a day or two after the accident seems an unnecessary procedure. The articles which show pictures of patients who had a fracture a few days before and now are riding around in a wheelchair are spectacular but that is all.

In bed these patients can roll around, sit up, be turned on their face and have ample ventilation of the lungs. Also this bed exercise is better for circulation of the extremities than sitting motionless in a chair. They can leave the hospital and stay in bed at home without great expense. If the patients are kept in bed for a minimum of eight weeks and on crutches for a minimum of six months, the incidence of aseptic necrosis will be minimal.

I have just finished a study of a series of traumatic dislocations of the hip in which I found that the patients that had associated injuries, such as fracture of the shaft of the femur or tibia which compelled them to stay in bed, ended up with excellent hips. On the other hand, those patients who got up early and bore partial weight with crutches developed aseptic necrosis. I think the same thing obtains in the fractured hip cases. As Dr. Carothers mentioned many of these patients are senile, frail old women and if they are placed in a walker on the fourth or fifth postoperative day, it is hard to believe that they do not occasionally bear full weight on the affected limb.

As to the question of the open operation John Fahey of Chicago has demonstrated very beautifully in injection specimens that the main blood supply to the head of the femur comes through the posterior capsule so there is no harm in incising the anterior capsule. The original Smith-Petersen operation involved opening the whole hip joint by an anterior approach and then inserting a nail through a lateral exposure of the trochanter. Use of the single lateral incision is no more shocking than the so-called blind nailing. A quick operation by direct exposure of the fracture is less strenuous than a long "blind" procedure.

Perfect reduction of the fracture, complete immobilization of the fragments with internal fixation and prolonged protection of the hip against

weight bearing will do more than anything to eliminate late aseptic necrosis of the head of the femur.

ESLIE ASBURY (Cincinnati, Ohio): Each one of the speakers has made a direct contribution, and from the discussions and the papers it seems that a good many more of us are going to have to make a good many more contributions before we will be satisfied with our results in these cases.

I think Dr. Cubbins made one of the more important points on this subject some years ago. He pointed out the absolute inevitably bad result that must occur in such a high percentage of these cases. Therefore, people who get terrifically high percentages of bony union without too high percentages of aseptic necrosis must be lucky in the cases that come to them.

In the first place, they would be fortunate in that they did not work in a charity hospital in a big city where they had a great many people with malnutrition and with possibly other advanced and neglected conditions. People who practice in the prairie country or the farming districts where the women are more active and out-of-doors and in better general condition will certainly have a much higher percentage of good results.

The whole thing depends upon not the method used but the adequacy of the method and the absolute realization in a very early period in the treatment of some of these cases that you are going to get a bad result with the method you are using.

Dr. Neer brought out the oblique fracture as one of the situations. As one of our New York members showed last year the messed-up case, that is, one requiring removal and replacement of nails or screws, probably should not be nailed but an osteotomy done as a primary procedure. People who have very bad bone, who have very friable bone that will not hold nails very well and those who we can see from past experience are going to give us inevitably bad results should have an osteotomy as soon as possible.

FRANK P. STRICKLER (Louisville, Ky.): I think it is well for some of the older men who were trained with Dr. Royal Whitman and Sir Robert Jones to discuss these papers as we have seen large numbers of fractures of the neck of the femur and are well acquainted with the development of the surgical treatment of this fracture also with all of its trials and tribulations. We must realize that we had aseptic necrosis of the head and neck of the femur before we ever nailed a fracture of the femur or introduced a foreign body into the head and neck of the femur.

Dr. Royal Whitman introduced his reconstruction operation to overcome the results of aseptic necrosis of the head and neck of the femur and also kept his patients at rest in a spica for three months and that in spite of rest and fixation,

aseptic necrosis did occasionally develop with the Whitman treatment.

We should remember that these patients are on the downhill side of life with all sorts of medical complications, lowered vitality and an impaired metabolism. They may have impaired circulation in the head and neck of the femur at the instant the fracture takes place, and if you start with a bad circulation you have an excellent opportunity to end with aseptic necrosis of the head and neck of the femur. In my opinion the end results will depend on whether the original circulation was good, bad or indifferent.

If there ever was a fracture in which we need a medical consultant, it is in fractures of the neck of the femur and I always have a medical man to help me on these cases. The patients are sick and debilitated to start with and there are all kinds of medical complications to meet. These patients require special diets, high in calcium and proteins, with vitamins, fruit juices, green vegetables, etc., and the medical man is the one to see that they get this attention. We have to consider the patient as a whole, along with his body chemistry, not just the fracture of the neck of the femur and the kind of nail we are going to use in the operation.

I have been nailing fractures of the neck of the femur for a good long time, and I have finally settled on the Smith-Petersen nail. We nail these fractures on a Hawley table, first reducing the fracture under x-ray control, taking antero-posterior and lateral x-rays. We use pentothal and oxygen anesthesia. We never use guide wires. I do not think the trauma caused by introducing these guide wires improves the circulation in the head and neck of the femur; besides, they are not at all necessary. If you know where the head of the femur is and how to drive a nail, that is all there is to the procedure. We use a large drill, slightly smaller than a Smith-Petersen nail, to get through the cortex just below the trochanter; then with two fingers and a sense of touch the job is done in thirty-five to forty-five minutes, including the x-ray check-up. Let me repeat again, guide wires are not necessary and these wires do cause a lot of trauma and do undoubtedly interfere with the circulation. I know of cases in which six and eight of these wires have been put into the head and neck of a femur. This also requires time and unnecessarily prolongs the operating time.

We put our patients to bed without fixation of any kind; sometime we may use a sandbag. The patient is kept in bed until the wound is healed and there is no danger of infection, then the patient is gotten up in a wheel chair, next a walker and at last crutches. We all know that it takes about one year for these patients to completely recover; however, the patient is usually walking in three weeks.

Everyone who has been in surgery or medicine for any period of time knows that elderly patients do not do well if left in bed any prolonged length of time; they become confused mentally, their appetite is impaired, they have chest complications and they are beset by all the ills they had previous to the fracture and the desire to recover is soon lost. It is not showmanship to get these patients out of bed, but good common sense. In my opinion the sooner you get these patients out of bed on a well regulated diet and under the care of a good medical man the sooner you are going to get much better results.

Some of these patients can not be nailed at once; some of them are in severe shock and have medical complications that delay the operation. This also applies to many other fractures. The whole subject of fractures is being treated entirely too casually by many doctors. Fractures are a serious, costly business. They should not be taken as soon as they enter the hospital and put on an operating table while they are still in shock and have a thoughtless surgeon put thirty to fifty sutures in a scalp wound, many times without even a local anesthetic, when the scalp wound is of secondary consideration and can be sutured at any time.

Recently in two large teaching hospitals, I know of an extensive fracture of the pelvis that was not found in a seriously injured patient. Another instance I know of was a small boy with a fracture of the middle third of the femur who was put to bed for forty-eight hours without a splint or traction. Instances of this sort should not occur in teaching hospitals.

JOHN E. CANNADAY (Charleston, W. Va.): Not sufficient attention is being paid to restoring circulation to the fractured neck of the femur in these intracapsular fractures. I have noticed in recent reports from Norway, also from the Cleveland Clinic, the increasing use of the crest of the ilium for bone pegging, also that fragments of iliac bone are being used successfully to restore circulation to the detached head of the femur, likewise to promote union in the fractured os calcis.

BOARDMAN BOSWORTH (Bronxville, N. Y.): Dr. Strickler has stolen much of my thunder. It does seem to me that the whole history of the development of the treatment of fractures of the neck of the femur entirely refutes Dr. Stuck's position, with all due respect to Dr. Stuck.

We started with traction, then with the Whitman abduction spike, then with nails, pins and what have you for internal fixation. The whole purpose of each of them was a step forward toward mobilization of the patient, purposely so designed because of the type of patient you were dealing with, the age level in which he fell, the complications which were to be expected in a patient of that age and degenerative conditions at that time of life.

It does seem to me, in agreement with Dr. Strickler, that we have to think primarily of the patient as a patient whom we want to replace as nearly as possible in her previous condition and as quickly as we can do it.

Why should we put a patient to bed and keep her in bed for eight weeks when all she has is a simple fracture of the neck of the femur which can be held in position perfectly adequately by some form of internal fixation? It does not matter which you choose. I grant you that the patient should be individualized. There will be certain of these patients who will have bad cardiac conditions, but if they do not have those restrictions then I am all in favor of getting them out of bed, not as a spectacular gesture, but for the sake of a live patient.

J. T. F. GALLAGHER (closing): I want to thank Drs. Speed, Carothers, Stuck and Asbury for their helpful suggestions. I might add that in the past eighteen months our postoperative care has been radically changed. No patient is allowed weight bearing for three or four months, and they all wear walking calipers for one to one and one-half years. Although it is too early to draw definite conclusions, the end results to date in this series are far more favorable.





# MANAGEMENT OF WAR INJURIES TO PERIPHERAL NERVES

W. K. LIVINGSTON, M.D.

*Portland, Oregon*

THE purpose behind this series of papers dealing with the handling of special types of war casualty cases is to frankly evaluate the faults in the methods adopted in the last war, with a view to bringing out constructive suggestions as to the handling of such cases in the event of another war. It must be realized at the outset of this discussion that each one of us saw but one small segment of a most complex situation so that the criticisms we may voice may be unfair to the overburdened authorities against whom they appear to be directed. We must also realize that the faults as we saw them in the last war belong in two categories, in only one of which could our opinion be considered authoritative. The first category includes the faults inherent in any military regimen suddenly called upon to deal with large numbers of wounded men after a long period of relative stagnation during peacetime. The second category covers those faults applicable to the handling of particular kinds of war injury. Perhaps we should confine our discussion to this latter category of faults which involve our own specialty fields. Yet the two categories are so intimately related that it is impossible to consider one without regard to the other.

Although each of us represents a different specialty in the field of surgery, we had one experience in common. At the termination of the war each of us was fortunate enough to be handling the particular type of patient which our training and experience best qualified us to treat. We had reason to believe that we were contributing to better end results in these cases. We were justifiably proud of the fact that our efforts might well lessen the permanent disability for these wounded men and proportionately diminish the economic burden that they would ultimately impose on society. The principal regret that each of us had in this culminating phase of our war experience was that the improved care of these surgical problem cases had not been instituted at an earlier date. The essential question with which we are

concerned today is how the delays and faults we encountered in the last war might be lessened or eliminated in future wars. I believe that the best approach to this question is to relate our individual experiences and by pooling our impressions we may be able to agree on valid criticisms of past procedure and, from these, constructive suggestions may emerge.

During the greater part of the war our Naval Hospital acted as a receiving hospital through which great drafts of men poured from the Pacific area to be distributed to other mainland hospitals. The wounded were handled in drafts, and not infrequently the hospital admitted more than 1,000 new patients in a single day. At the peak of our load in 1944 there were 57,000 new admissions which meant approximately a complete turnover of our full bed capacity each month. There were times in which we had a serious shortage of medical officers to handle these wounded men. Yet within a few miles of us were two great camps in which hundreds of naval medical officers were marking time while they waited for orders from Washington. Among these men were many specialists whose services would have been invaluable to us and hundreds of younger men eager for the hospital experience we could have offered them. These medical officers "stewed in their own juices" for months at a time and no one in our naval district had the authority to give these men temporary assignments or to see that when they received orders from Washington the duty was such as to fit their particular talents.

The waste of special talent was also apparent within the hospital itself. Not only was there insufficient clerical help on the wards, but nurses, corpsmen and Waves were constantly changing. Proper care of those with peripheral nerve injuries requires special skills, and no sooner did one of these persons begin to acquire that skill than they were moved elsewhere. The need for special training was even more obvious among the medical officers assigned to help with the work on our wards. Not only was



special skill needed in the surgical treatment of nerve injuries, but in the study of these cases upon which decisions as to treatment and prognosis must depend. For the first half of the war the average stay of these young medical officers on my ward was less than one month. In addition, the necessity for filling the outgoing drafts required that we ship out nerve patients regardless of the stage of their investigation and treatment.

In the final phase of the war this grim picture changed considerably. Much of this change was due to the efforts of our commanding officer. He appreciated the improved care of surgical problems that could be afforded on the specialty wards, and he made every effort to provide the specialists with the equipment they needed and to assure some continuity of service in personnel. There was also evidence that the Bureau of Medicine and Surgery in Washington was becoming aware of the specialty care of surgical problems. Centers were established to which particular kinds of cases were to be assigned; young medical officers were sent to these centers for training and with some prospect of greater continuity of service and greater efforts were made to supply the centers with the equipment and personnel that they needed. Our hospital was designated as a center for peripheral nerve injuries, and in a small measure we were able to carry out parts of the program for their care that had been so well established by the British. In my opinion neither the Navy nor the Army ever approximated a full implementation of the excellent British program for the handling of nerve injuries. And the sad commentary on the British plan was that it was available to our military authorities in its complete form before the United States entered the war.

To return to the problems peculiar to nerve injuries we learned something about them even during the difficult and confused early phases of the war. At this time the lack of transport delayed evacuation of wounded men from the Pacific area to the mainland hospitals for long periods. Even during the second year of the war the time interval between wounding and admission to our hospital for these nerve patients averaged five and one-half months. In this interval most of the men had been moved from one hospital unit to another, rarely staying long enough in one place to permit adequate

investigation or treatment. This long delay was certainly regrettable, but it taught us two lessons which might otherwise have escaped attention.

First, we were surprised to find that after months of complete nerve paralysis some of our patients were showing signs of spontaneous recovery of function. In certain of these cases one could feel a neuromatous enlargement of the nerve trunk near the level of wounding, and yet both sensory and motor function were already well established distal to the local lesion. High velocity missiles release enormous energies in their wake which tear or stretch nerves to produce disruption of nerve fibers without actual interruption of the nerve trunk. Our observations indicated that in a considerable number of "lesions in continuity" a spontaneous recovery of function occurred that was more complete than a surgeon could hope to confer by resection of the local lesion and end-to-end suture of the nerve trunk. Yet I am convinced that had we explored these patients while their paralysis was complete we would have resected the local lesion. Unless we had seen for ourselves how complete spontaneous regeneration may be through many of the lesions in continuity, I know that we would have resected many of them without ever questioning the advisability of this procedure. These observations led us to be very conservative in the treatment of any nerve lesion in which there was any reasonable chance for spontaneous regeneration.

A second lesson that the last war taught was that attempts to repair surgically nerve injuries immediately after wounding are ill advised. The British have clearly shown that entirely aside from the hazards of infection and inadequate surgery in the front areas, the end results are better after *early secondary* repair of nerve lesions than after immediate repair. The optimum time for nerve suture seems to be three or four weeks after a nerve has been severed although under war conditions any time within the first three months could properly be considered as *early secondary* suture. These facts have a bearing on the handling of nerve casualty patients, in that it does not seem to be imperative that trained surgical teams operate in the front areas. These patients could be handled by general surgeons exactly as are those with wounds uncomplicated by nerve injury except that a

careful record should be made as to the exact status of the sensory and motor findings during this early period of observation. If good records were kept, there would be no necessity for giving nerve patients a high priority in being evacuated so long as they reached a center designated for their care within the first month or two after wounding.

The delay that occurred in evacuating the wounded to mainland hospitals in the last war taught one other lesson which was that plaster casts should not be used to support paralyzed muscles in the uncomplicated case of nerve injury. Our medical officers had been taught that all paralyzed muscles should be supported to prevent overstretching and contractures. Since light splints were not available to them, they used plaster casts. In the months that elapsed between wounding and the time these men reached us they wore these plaster casts continuously. They were moved so frequently from one hospital unit to another that no one had time to investigate them well and as long as the plaster cast was reasonably comfortable and rigid it was left on. If it had to be removed for some reason and the paralysis was still present, a new cast was applied. By the time these men reached us the muscle atrophy and joint stiffness resulting from the long period of immobilization were often of as serious consequence as the nerve lesion itself. The first standing order issued on the peripheral nerve wards of our hospital was that all plaster casts must be bivalved within twenty-four hours of the patient's admission. It was most unusual to find any justification for a re-application of a rigid support. Active use of the affected limb was of such importance in these cases that we seldom used even the lightest splints. In fact, our staff came to doubt the advisability of routine splinting for any uncomplicated case of peripheral nerve injury. I shall not attempt to justify this view here, but there can be no argument over the fact that rigid immobilization of paralyzed muscles for extended periods can do much more harm than no splinting at all.

There are other problems relating to the surgical handling of peripheral nerve injuries which might be mentioned, relating to suture material, grafts, protective sleeves, prognostic testing and the like, but these are technical problems which have no place in this group discussion. If specialty patients are segregated

and are placed under the care of properly trained medical officers, these questions will answer themselves. The point which we must emphasize is that prewar planning must provide for such segregation and the delegation of sufficient authority to the specialist to enable him to give his patient adequate care. I am aware that certain reservists are cooperating with the military authorities in the Medical Corps of both the Army and the Navy in making prewar plans and that a few medical officers in active service are being certified by the specialty Boards. An authority has told me that, "as soon as a war is declared and mobilization well under way, the qualified specialists in the Navy and among the Reserves will automatically get together and decide upon an over-all plan from the time the peripheral nerve is injured until rehabilitation is complete." Personally, I have no faith in this optimistic prediction. There is no way for specialists to "automatically get together" unless this is arranged for as part of a definite plan, and even if they are successful in getting together it is to be doubted that they will have the authority to implement their recommendations. Once mobilization gets under way these men will again be lost in the shuffle and their efforts will be effectively stifled by superior officers who have neither insight into specialty problems nor tolerance for the specialist. Unless there is a definite prewar plan for the handling of specialty patients and some alteration in the general attitude toward the specialist among the regulars, I predict that we will witness the same waste of surgical talent which was so distressing in the last war. If I were to list the things which I think prewar planning should provide for as a minimal provision for the handling of peripheral nerve injuries, these would be included: (1) The establishment of centers for the special care of peripheral nerve injuries. These patients should be evacuated from the front areas to a center as soon as possible after the more critical casualty patients have been cared for. (2) Provide that each nerve patient be sent to the mainland center nearest his home and keep him there until his final disposition. (3) Put the best available specialists in charge of these specialty patients and provide them with the equipment and assistance they need for efficient service. (Adequate assistance should include clerical help.) Strictly medical decisions relat-

ing to patient care should be in his hands even though ward responsibility may be shared by less well trained officers of higher rank. (4) Give these centers the responsibility for training young medical officers in specialty work. Give these trainees sufficiently long term assignments to this duty to assure continuity of service. (5) Provide for the patients vocational training, recreational facilities, and a liberal "leave" policy. Peripheral nerve patients have long periods between stages in surgical treatment during which hospitalization is not a necessity. Judicious use of extended leaves tends to maintain good morale and to make additional beds available. (6) Last, but not least, abolish the saying, "You are a Naval Officer first, a doctor second, and a specialist last, if ever" as well as the attitude which such a statement connotes.

It is this last point that I would like to amplify in my closing comments. I think the specialists from the medical reserve did a fine job in World War II. I am willing to believe that the military authorities recognized this service in the last few months of the war and were sincere when they tried to get many of these men to remain in active service. If the authorities in Washington had been a little less set in their ways and willing to give assurance that these men would be retained in their specialist capacity to care for patients, to train young medical officers and to have an active part in prewar planning, some of these men would have remained in service no matter

what personal sacrifice it might have entailed. But in the absence of any such assurances and with no reason to believe that the prewar planning would be any more apt to conserve medical talent than it did in the last war, the self-respect of these men demanded that they leave active service. It is exactly these same considerations which have influenced most of these men to resign their commissions in the reserve corps. I am convinced that these resignations are not a sign of lack of patriotism. I am sure that if another war should come these men will be back in service, but they believe, and I for one believe they are justified in this feeling, that their chances of getting an assignment for which they are particularly fitted would be better if they were completely outside the reserves than if they retained their commissions.

I am confident that there are many specialists formerly in the reserves who could be persuaded to undertake the training of medical officers in their special field of surgery right now, and I am sure that many of them would be glad to assist in prewar planning, at least insofar as the handling of special types of patients is concerned. To enlist their aid should require little more than good evidence that the regular's attitude toward the specialist had undergone a change, and an assurance that what they helped plan for in the event of another war would have a reasonable chance of accomplishment.



# HANDLING OF TRAUMA IN THE UNITED STATES NAVY\*

REAR ADMIRAL ARTHUR H. DEARING

*Medical Corps, U. S. Navy*

THE actual treatment of traumatized individuals in the Navy does not differ greatly from such treatment in civil medicine. It is in the factors that govern this treatment, the environment in which it must be carried out and the large number of war casualties which flow to the hospitals that differences exist.

In peacetime the treatment and organization for treatment of trauma in the naval service is not unlike any far-flung industrial organization. There are well equipped dispensaries at the large Navy Yards and shore stations with excellent hospitals nearby to which the injured man or woman may be sent if hospitalization is needed. The same situation exists at our large overseas naval bases. At smaller bases, if no hospital is present and treatment is beyond the facilities and equipment of the medical officer present, air transportation provides easy and rapid transit to a hospital. Large concentrations of ships afloat and away from our coasts usually have with them a completely equipped hospital ship. Solitary ships anywhere in the world can quickly obtain the specialized services of a skilled medical officer and rapid transportation to a modern hospital in this day of radio and swift air transport. As a matter of fact the Naval Air Transportation System maintains regularly scheduled hospital flights on a world-wide basis. The bluejacket injured in an accident aboard a ship in the Mediterranean may be in a Naval Hospital in New York or Philadelphia within seventy-two hours after injury.

However, it is in time of war that conditions exist and factors come into play that complicate the treatment of casualties, necessitate an elaborate organization for such treatment and profoundly influence all personnel involved in treating casualties and the end result as far as the patient is concerned. Thousands of doctors came in contact with these factors during World War II and were influenced by them; some were irritated by them, a few never understood them but the vast majority accepted the

conditions imposed by war. The results speak for themselves for our recovery rate was higher than in any war—98 per cent of the wounded survived.

The first objective in the treatment of casualties in the Navy as anywhere is to save life. That comes first, save the man's life. The second objective is to heal his wounds as rapidly as possible, effect his rehabilitation and get him back to duty, aboard ship, at a Naval Station, in a Marine Regiment, at an air station or wherever he is needed, but get him back on the job to do his part as a trained sailor or marine to help defeat the enemy.

The prime factor which influences the surgery of trauma in the Navy during war is the necessity for frequent transfer of the patient from one hospital and the care of one surgeon, to another hospital and another surgeon. This goes on from the time the man is injured aboard ship or in the field until he reaches the hospital where his treatment and rehabilitation are completed. This necessity to transfer the patient from professional hand-to-hand is the direct opposite of civilian life when the individual who is injured is usually placed under the care of a surgeon within a very short time after the injury and almost invariably continues under the care of that individual surgeon until his recovery is complete. It is the organization to accomplish this movement and to ensure continuity of treatment that was developed and improved in World War II.

The surgery of trauma in the Navy during World War II may be divided into two categories: First, trauma occurring at sea aboard ship and second, trauma ashore as seen particularly in the Marine Corps which is an integral part of the Navy.

## CASUALTIES AT SEA

One characteristic of naval warfare as distinct from land warfare is that the number of killed equals or exceeds the number of wounded. (Table I.) This may not hold true for an indi-

\* The opinions and views contained in this article are those of the writer and are not to be considered as reflecting the policies of the Navy Department.

vidual engagement or ship but in the aggregate it still holds. It is due to such factors as the confinement of personnel in closed spaces aboard ship where fire, blast and explosions kill all hands, immersion, drowning, etc. Paradoxical as it may seem in Naval warfare the

although details vary according to the type of ship. These principles are: (1) Training of all personnel in the fundamentals of first aid so that it may be given to the wounded man by whoever is nearest and free to do so. (2) Distribution throughout the ship of teams of

TABLE I  
CASUALTIES DUE TO ENEMY ACTION, U. S. NAVY,  
DECEMBER 7, 1941 TO DECEMBER 31, 1946\*

Method of Disposition	Navy		
	Total	Officer	Enlisted
Total.....	68,897	6,684	62,213
Killed in action.....	34,625	3,655	30,970
Died prisoner of war.....	891	134	757
Wounded:			
Died subsequently.....	922	66	856
To duty.....	27,784	2,784	25,000
Invalided from service....	4,558	30	4,528
Deserted.. .....	6	.....	6
Disposition undetermined †	111	15	96

\* Source: "K" file card, "Individual Statistical Report of Patient"; data are provisional as of July 1, 1947, date of compilation.  
† Includes patients remaining on the sick list (319 as of July 1, 1947), and those whose records are lost or otherwise unavailable; no deaths are included in this total.

opponents are seeking to destroy the ships and their usefulness rather than directing their main efforts toward killing personnel. In land warfare, where the wounded always greatly exceed the killed, the opponents attempt to kill personnel rather than necessarily destroy material. (Table II.)

Certain types of trauma are more frequent aboard naval ships due to the peculiarities of naval warfare: Burns are usually present in large numbers due to the flash of exploding shells and bombs, escaping steam from ruptured lines and fires generated by the heat of explosion. Fractures of both lower extremities and the spine are due to force from below lifting the deck on which personnel are standing. These are characteristic of torpedo and submarine mine explosions. Blast injuries occur due to proximity to explosions, particularly among personnel in the water not sufficiently distant from the shock waves of exploding bombs, depth charges and torpedoes.

The organization and training for handling casualties aboard ship follow certain principles

TABLE II  
CASUALTIES DUE TO ENEMY ACTION, U. S. MARINE CORPS,  
DECEMBER 7, 1941 TO DECEMBER 31, 1946\*

Method of Disposition	Marine Corps		
	Total	Officer	Enlisted
Total.....	74,219	3,824	70,395
Killed in action.....	17,099	1,192	15,907
Died prisoner of war.....	513	62	451
Wounded:			
Died subsequently.....	1,629	87	1,542
To duty.....	44,551	2,405	42,146
Invalided from service....	9,968	41	9,927
Deserted.....	34	1	33
Disposition undetermined †	425	36	389

\* Source: "K" file card, "Individual Statistical Report of Patient"; data are provisional as of July 1, 1947, date of compilation.  
† Includes patients remaining on the sick list (319 as of July 1, 1947), and those whose records are lost or otherwise unavailable; no deaths are included in this total.

hospital corpsmen and stretcher bearers who may go to the scene of the casualty with the material repair party, collect the wounded, give further first aid and transport them to a protected area or collecting station. (3) Life saving measures by the medical officers, such as treatment of shock and arrest of hemorrhage, splinting of fractures, dressing of wounds and emergency major surgery. (4) Transfer from the combatant ship to a hospital ship or shore hospital at the earliest possible opportunity. This transfer may be by small boat but in the recent war intership transfer at sea with both ships under way was highly developed.

The general principle in caring for casualties is to save life, prepare casualties for transfer and get them clear of the ship at once in order that the ship may be ready for further action if necessary. The wounded arrive eventually at a base hospital somewhere in the zone of communication.

MARINE CORPS CASUALTIES

The amphibious operation of bringing an offensive force to an enemy stronghold, landing

it on a strongly held beach against opposition and supporting it until it has secured a firm foothold is an operation requiring the utmost cooperation of sea, air and ground forces. The Marine Corps which is a part of the Navy were the pioneers in amphibious warfare and their

stretcher bearers where a beach medical officer continues their care, sorts them and directs their transfer by boat to appropriate ships. As the assault line moves inward from the beach more medical components come ashore from the transports, battalion aid sta-

TABLE III

WORLD WAR II CASUALTIES DUE TO ENEMY ACTION U.S. MARINE CORPS; SELECTED ENGAGEMENTS  
DECEMBER 7, 1941 TO DECEMBER 31, 1946

Place of Action	No. of Marines Engaged	Casualties Due to Enemy Action					
		Total		Killed		Wounded	
		No.	Per Cent	No.	Per Cent	No.	Per Cent
Guadalcanal-Tulagi landings.....	32,650	3,900	11.9	1,078	3.3	2,822	8.6
Battle of Tarawa.....	17,000	3,074	18.1	988	5.8	2,086	12.3
Battle of Cape Gloucester.....	17,000	1,446	8.5	358	2.1	1,088	6.4
Invasion of Marshall Island.....	15,600	1,638	10.5	434	2.8	1,204	7.7
Invasion of Mariannas Islands.....	127,800	17,163	13.4	4,335	3.4	12,828	10.0
Invasion of Palau Islands.....	24,800	6,388	25.6	1,273	5.1	5,115	20.6
Battle of Iwo Jima.....	61,000	19,001	31.1	5,523	9.1	13,478	22.0
Bombardment and landings on Okinawa.....	72,800	14,749	20.3	3,242	4.5	11,507	15.8

several major operations in this field resulted in thousands of casualties during the recent war. (Table III.) As the medical component of the Marine Corps consists of Naval medical personnel the care of these casualties was and is the responsibility of the Naval Medical Department.

As long as the Marine is aboard ship, either for duty or enroute to an assault, he is subject to the same hazards as previously described. The medical officer of the ship cares for him if he is wounded and the ship's organization is responsible for his disposition. As soon as he lands on the beach the medical organization of his company, battalion or regiment cares for him if wounded. The nature of the wounds sustained in these operations are no different than in other military operations. There are the ragged wounds due to exploding shells and bombs, the wounds due to rifle and machine gun wounds and bayonet wounds incurred in close combat.

The wounded of the first assault waves are given first aid by the hospital corpsmen and medical officers attached to their companies or battalions. They are carried to the beach by

tions are established and soon a medical battalion may erect a field hospital in which major surgery is carried on within a relatively short distance from the front lines. Specialized equipment which may be quickly transported to the beach and put in use rapidly has been developed, e.g., mobile surgical trailer. Surgical teams which have been working aboard ship come ashore early and continue their work in the mobile operating rooms.

In 1942, at our first amphibious assaults, wounded were returned by boat (the same boats that brought the assault troops ashore) to the transports. Here they were treated by the ship's medical officer until the ship returned to base where they were transferred to a base hospital. Sorting of wounded on the beach was under difficulties, and boat transport was uncertain as the craft might be required for other more important missions.

As the war progressed the technics of transferring the wounded improved as hospital ships became available and special craft for sorting and transporting casualties were developed. In a large assault several hospital ships were made available. Special amphibious craft

were equipped for transporting the wounded. These picked up the wounded either at the battalion aid station or on the beach and carried them to an LST which was especially equipped for sorting and classifying the wounded. From these ships they were sent by hospital boats to the hospital ship lying offshore. When a hospital ship was filled, it departed for a base hospital and its place was taken by another. These hospital ships were fully equipped floating hospitals with medical staff, nurses, equipment, etc., as good as any modern hospital.

Later in the campaign, when enough territory had been secured and an airfield captured or built, air evacuation of the wounded was utilized. This method of transfer of casualties proved its efficacy early in the war. As planes and personnel became available air transport assumed increasing importance. In the Marianas campaign in 1944 less than 10 per cent of the casualties were evacuated by air. In 1945, in the Okinawa campaign, 50 per cent of the casualties were evacuated by air.

#### HOSPITALIZATION IN REAR AREAS

The wounded man arrives at a base hospital in a rear area in the zone of communication whether his injury was sustained aboard ship, in aerial flight or on shore in an amphibious assault. He may have reached the base hospital by ship or plane. These base hospitals are fully equipped and staffed. The capacity may vary from 200 to 1,500 patients. Here the patient is fully evaluated, definitive treatment begun and the patient brought to the optimum condition for further transfer to the United States if this step is necessary.

If the patient's period of expected disability is relatively short he may be kept at a base hospital until fully recovered and then return to his ship or organization. He may be transferred from one hospital to another in the zone of communication for several reasons, such as to distribute the patient load, to be in a more salubrious climate or to receive specialized treatment in a hospital designated for treatment of special cases, such as head injuries, thoracic wounds, compound fractures, etc.

In the base hospitals a policy must be formulated to serve as a guide in determining which patients shall be transferred to the United States for treatment. Certain casualties such as the amputees, the blind, those with severe

injuries of the nervous system, femur fractures, etc., must obviously be transferred to the United States. In the South Pacific area in 1942 to 1943 the policy was that any patient in a base hospital who was expected to require ninety days or more of treatment would return to the United States. This time limit is variable and may depend on the following factors. (1) Need for hospital beds; (2) distance to the United States; (3) speed and availability of transport to United States and (4) climate of the rear area (tropical or subtropical). In any event it is probable that an average of 75 per cent of the casualties reaching a base hospital in the zone of communication (rear area) will require transfer to the United States for completion of treatment. This transfer may be by ship or plane. In World War II it was at first almost exclusively by ship. Later, as planes became available, air transport of stretcher casualties to the United States was the rule. If transferred by ship, they receive care enroute from the medical staff of the ship—usually only such care as is necessary to carry out the type of treatment already instituted. If transferred by plane, nursing care by the flight nurse and corpsmen is all that is necessary during the short period on board the plane.

#### DISTRIBUTION OF CASUALTIES WITHIN THE UNITED STATES

Casualties arrived in the United States at the Port of Embarkation and were transferred from plane or ship to the hospitals at that particular port. In the early days of the war the hospitals at our Pacific ports of embarkation were under considerable strain to handle the incoming patients. Our concept of the necessity of screening had not been fully developed and the large hospitals which were built at these ports found themselves in the position of receiving large groups of patients for screening and at the same time attempting to carry out definitive care for the patients already in the hospital. Later receiving hospitals were established at the Port of Embarkation which received all patients returning to the United States whether by ship or plane. At these receiving hospitals patients were screened and given necessary care, allowed to recover from the effects of their trip if it had been prolonged and then transferred on to other hospitals throughout the country. This transfer took



place by ambulance to hospitals within the immediate vicinity, by train for large groups of patients going a distance and by plane for small groups of patients or for those requiring rapid transfer to a special hospital. Later as more planes became available more of the

able for the reception of ambulatory patients in the convalescent stage who required some rehabilitation and time before returning to service. Theoretically this was an ideal arrangement but practically it did not work out too well for wounded patients. Pressure of incoming

TABLE IV  
TRANSFERS OF NAVY AND MARINE CORPS HOSPITAL  
PATIENTS AUTHORIZED BY THE BUREAU OF MEDICINE  
AND SURGERY 1944 TO 1947\*

Period of Time	No. of Patients	Type of Transfer
October to December, 1944	11,022	All transfers
1945	97,592	Transfers of overseas casualties and transfers for special-type treatments
1946	10,707	Transfers of overseas casualties; transfers for special-type treatments
1947	2,170	Transfers for special-type treatments

\* Source: Professional Division, Hospitalization Branch; all data are approximate; data include only those transfers authorized by the Bureau of Medicine and Surgery. Transfers between hospitals within a Naval district are authorized by the commandant of the district and are not included in these data; with the decrease in doctors, the number of transfers of patients for special-type treatments increased.

transfers were accomplished by air transportation. The distribution of these patients was controlled from a central source and their destination was usually dependent upon several factors. (Table iv.)

The first factor was the type of injury, for example, the Navy maintained amputation centers at the Naval Hospital at Mare Island and the Naval Hospital, Philadelphia. The center for the treatment of the blind was at the Naval Hospital, Philadelphia. Several hospitals were designated for plastic surgery and for surgery of the nervous system. The second factor was the man's home. If the proper type of hospital with vacant beds was located in the general vicinity of the patient's home, he was transferred to it. At these hospitals the patient's final definitive care was carried out and he either recovered and returned to a duty status or he was discharged from the service when hospital care was no longer needed. (Table v.)

Near several of our larger hospitals which carried heavy loads of casualties convalescent hospitals were established. These were avail-

TABLE V  
AREA OF RESIDENCE OF NAVAL PERSONNEL AND AREA  
DISTRIBUTION OF PATIENTS IN NAVAL HOSPITALS

	Residence of Naval Personnel (per cent)	Location of Patients in Hospitals (per cent)
Pacific states.....	10.9	47.1
Mountain states.....	3.4	3.7
Midwest, west of Mississippi.....	12.9	4.0
Midwest, east of Mississippi.....	25.8	6.2
Atlantic states.....	33.1	33.9
New England states.....	7.9	5.1

patients frequently resulted in patients being transferred to a convalescent hospital before they were ready for it. At best it resulted in the casualty being passed along into the care of another individual surgeon at perhaps the most critical period of his treatment.

Continued movement of the wounded man in wartime from the place of wounding to the hospital where he completes his treatment constitutes a major difference between wartime and peacetime care of casualties. It is almost as if the wounded man were on the belt of an assembly line moving away from the forward area with various individual medical officers and hospitals giving him treatment as he moves along toward his recovery or ultimate disposition. At any point as the belt moves along he may recover sufficiently to be taken off the line and be returned to his station or he may stay on the belt until he reaches the end which may be return to duty or discharge from the naval service. In general, it may be said that the farther along the assembly line the patient moves, the less chance there is that he will return to duty in the service. (Table vi.)

This organization for the treatment of casualties imposes on the service and its medical officers certain duties and obligations not always present in peacetime or civilian care of casualties. The first obligation is for some uniformity or standardization of method of treatment of each type of trauma. These standard methods must be established early



and all medical officers indoctrinated in them. Obviously if a man with a compound comminuted fracture of a major bone is to be treated by several surgeons successively, some unanimity of thinking is required for his treatment if proper results are to be obtained. If

TABLE VI

Theater of Operations	Flow of Casualties	Combat ships; amphibious assault troops; bases (front line); sea areas in dispute with enemy; enemy country (not secured)
Zone of Communication		Overseas bases; island possessions; advanced bases
Zone of Interior		Continental United States

the first surgeon uses reduction and fixation by the Stader apparatus, the second disagrees and substitutes a Roger Anderson fixation, the third believes plaster alone is sufficient and the fourth perhaps favors traction, the patient recovers good function in spite of rather than because of his treatment.

Basic standard procedures for general use must be determined for each particular type of trauma. These basic standard procedures must permit flexibility of application and adaptation to variants of each type of trauma. There must be training in these basic procedures and training for flexibility of application. Once determined and established these standard procedures must be widely promulgated and all must abide by them. I venture that in the event of another war the same tenets will hold regarding the treatment of the hundreds of thousands of civilian casualties we may expect. War is not the time for individual surgeons to ride their own hobbies or perfect their own methods if they are at variance with the standard treatment. It is along these lines that the American Association for the Surgery of Trauma can do yeoman work in determining the basic standard procedures and indoctrinating the surgical profession in their technics.

Another duty imposed on all who treat this wounded man on the moving belt is the keeping of careful records. Not only the keeping of accurate, detailed records but the forwarding of these records with the patient to the next hospital when he is transferred. In peacetime or in civilian life case records are kept for

several reasons, such as hospital files, for study and evaluation of methods of treatment, statistical purposes, legal uses, etc. Case records of war casualties may be used for any of these purposes but their primary object is to pass on to each succeeding medical officer a complete, succinct record of all that has gone before in the history, progress and treatment of each casualty. These records together with x-ray films and other pertinent laboratory data should always go with the patient. Copies may be placed in hospital files but complete records must go with the patient to ensure continuity of treatment at all times.

LESSONS FROM WORLD WAR II

Every war in which this country has been engaged has had its own pattern. In planning our measures for care of naval casualties in the event of another war we must not fall into the error of basing all our plans on the pattern of the last war. However, certain concepts were developed which we may expect to be useful in any future war.

First, rapid evacuation of casualties by air transport to modern, highly equipped base hospitals with well trained staffs within easy reach of the forward areas. Second, utilization of air transport to move casualties from base hospitals to the United States thus avoiding the days and weeks of a sea voyage when treatment tends to be static rather than advancing. Third, establishment at Ports of Debarkation in the United States of receiving hospitals whose only function is the reception of overseas casualties screening and early transfer to appropriate hospitals. Fourth, establishment throughout the country of hospitals devoted to specialized treatment of various types of trauma, such as plastic surgery, amputations, peripheral neurosurgery and the blind and the deaf.

In summary, it may be said that the organization within the Navy for the care of casualties in war calls for team work and cooperation of the highest order. Basic standard procedures or uniform methods of treatment must be developed and adhered to by all hands participating in the immediate care of the patient. The rôle of this Association in developing these methods and inculcating the medical profession with proper technics can be of immeasurable assistance in preparing to resist future aggression.

# TRANSITION IN BURN TREATMENT

## THE WAR YEARS

DONALD M. GLOVER, M.D.  
Cleveland, Ohio

**D**URING the past thirty years which have encompassed two world wars treatment of burns has undergone considerable metamorphosis. Since this interval coincides with the time during which the author has been actively interested in burn treatment, it provides a convenient period for cursory review preliminary to mapping present trends.

At the beginning of World War I the common methods of burn treatment were applications of carron oil or various ointments, open air drying under a cradle and warm tub baths. During that war the ambrine or paraffin spray method of local treatment became popular. It was in fairly general use until the beginning of the coagulation regimen (1925), and it was adhered to by some throughout the latter era. Introduction of the Carrel-Dakin method of treating infected wounds at about the same time as ambrine came into use also greatly influenced subsequent burn treatment.

Beginning with the publication by Davidson of observations on the coagulation of burns with tannic acid, a trend was instituted which dominated burn literature in all languages until the early years of World War II. In the meantime brief flurries of interest have been recorded in cod liver oil, "shot-gun" ointments of various sorts, various preparations containing sulfa drugs and the application of inert films to the burned surface.

Prior to the entrance of the United States into World War II British observers had objected to the use of coagulating agents upon burns of the hands or face on the grounds that these substances destroyed epidermis not damaged by the burn. Then followed, chiefly by the British, the advocacy of warm saline baths and the Bunyan envelope.<sup>12</sup> In the meantime Allen and Koch<sup>3</sup> had reported in the American literature the use of fine mesh dry or petrolatum gauze in the local treatment of burns. Following the trend in the British literature, a number of observers began to question not only the local destructive effect of tannic acid on epidermis but brought forth clinical

and experimental evidence to indicate that tannic acid produced liver necrosis.<sup>5,8,10,25,30,44</sup> The observations of the Boston group on the victims of the Cocoanut Grove fire produced further doubt concerning the virtue of the coagulation regimen.<sup>20</sup>

The death knell of the regimen was sounded by McClure before the American Surgical Association in 1944,<sup>34</sup> by an editorial in the *Journal of the American Medical Association*<sup>23</sup> and by the Surgeon General of the United States Army whose circular letter in September, 1944 and TB Med. No. 15, March, 1945 prohibited the use of the coagulation regimen by the Medical Corps of the Army and made the vaseline pressure dressing the official method of burn treatment. The action of the Surgeon General was predicated upon the recommendations of the National Research Council and the Committee on Medical Research.<sup>31</sup>

Review of the published observations which led to the condemnation of the coagulation regimen leaves one in some doubt concerning the relative significance of liver changes produced by tannic acid in animals and those which had been known for years to occur in the liver of the severely burned patient.<sup>6</sup> Some of the observations could have been more adequately controlled. Be that as it may, the coagulation regimen has been buried by the weight of professional opinion. It has been superseded by what is usually called the vaseline pressure dressing, a method which is in most respects comparable to the ambrine dressings used in World War I.

## THEORETICAL CONSIDERATIONS

From the time of early observers it has been assumed that a toxic substance was produced at the site of the burn and that this was the lethal factor.<sup>6,45</sup> This theory has never been proven nor disproven. It was to fix this theoretical toxin that Davidson instituted the tannic acid regimen. Some evidence has been produced that this unknown substance may be a product of the protein breakdown at the site

of the burn. Some evidence suggests that it may be an enzyme.<sup>7,47</sup> Underhill<sup>43</sup> and his associates explained all the lethal effects of the burn by anhydremia. More recent experimental work<sup>15,24</sup> makes it clear that rapid fluid shift plays an important part in producing the systemic effects of burning and that this process can be limited to some extent by a pressure dressing.<sup>14,16</sup> Aldrich<sup>2</sup> attempted to explain the lethal effects of burns as due to the products of bacterial growth at the site of the burn. While there can be little doubt that infection plays a significant rôle in some of the late deaths, there is little evidence to support it as an early cause of death.

While most of the physiologic effects of burning can be explained upon a physiochemical basis, most experienced observers believe that there is an unknown factor which occasionally causes death which cannot be adequately explained on the basis of known phenomena. Bosse, Gross and Hagan<sup>9</sup> called attention to the unreliability of hemoconcentration and hypoproteinemia as a prognostic indication in certain burned animals. This fact has been confirmed by the author.

*Control of Shock and Fluid Balance.* The importance of fluid replacement in shock associated with severe burns has long been recognized. The work of Underhill and that of Collier and his associates focused attention upon this factor. The tendency during the twenties was to use large amounts of electrolyte fluid alone to combat shock and maintain fluid balance. It was found, however, that fluid given parenterally in excess during the early days of the burn led to generalized edema. With recognition of the fact that the protein content of the blister fluid as well as that accumulated in the subcutaneous tissue at the site of the burn caused depletion of protein reserves, the value of replacement with protein-containing fluid was established.

At the beginning of World War II large amounts of human plasma were recommended during the "shock phase" of the burn. This seemed logical and was found to be a better method of combatting shock than electrolyte fluid alone. Patients still continued to show edema, however, and in some shock was not overcome by the plasma. While before this time Riehl,<sup>39</sup> Scudder<sup>40</sup> and Harkins<sup>29</sup> had recommended the use of whole blood during the early stage of burn treatment, the general

belief was that to add red cells to the circulation was to increase the concentration that already existed.

It was customary to see oliguria during the second to fourth day of the severe burn, during which interval the urine contained protein, hemoglobin, casts and sometimes red cells. Then around the tenth day the output would often exceed the intake. This renal depression was thought to be due to the burn toxin. The work of Bywaters,<sup>18</sup> Olsen and Necheles,<sup>31</sup> Mallory and others, showing that the convoluted tubules are blocked due to severe shock, probably explains the phenomena better. Shen and Ham<sup>41</sup> showed both *in vitro* and *in vivo* that exposure to high temperatures even for short intervals produced fragmentation and increased fragility of the circulating red cells. This explains even more fully the blockade of the renal tubules and the finding of hemoglobinuria and hematuria. Their work also explains the common finding of secondary anemia when the shock phase of the burn is over, an anemia which we were formerly inclined to attribute to the result of absorption of bacterial products from the surface of the burn. Moore, Peacock, Blakely and Cope<sup>35</sup> showed convincingly that the "false" anemia of the second degree burn was due to dilution while the true anemia of the third degree burn was due in the earliest stage of the burn to hemolysis, later due to injury of the red cells and depression of bone marrow and still later due to infection about and hemorrhage from the granulating wound. McDonald, Cadman and Scudder<sup>35</sup> also showed that in second degree burns the plasma loss is greater while in third degree burns the red cell mass is depleted.

The rationale of the present trend to combat burn shock with whole blood plus electrolyte solution limiting the administration of plasma becomes apparent. Practical experience during the last war impressed the necessity of whole blood rather than plasma for the control of severe shock, regardless of its cause. The danger of producing homologous serum hepatitis from pooled plasma is a further deterrent to its use in large quantities. Recent experience would seem to indicate that the use of whole blood during the stage of shock and anhydremia when accompanied by an appropriate volume of electrolyte solution does not increase hemoconcentration. Much helpful experimental and clinical work has been reported by Abbott and

associates,<sup>1</sup> Cameron,<sup>15</sup> Collier and his associates,<sup>18</sup> Cope, Moore and their associates,<sup>21,36,37</sup> Elman,<sup>24</sup> Evans and Bigger,<sup>26</sup> Harkins,<sup>29</sup> McDonald, Cadman and Scudder<sup>35</sup> and Olsen and Necheles.<sup>38</sup> The weight of evidence seems to favor a judicious combination of whole blood, electrolyte solution and plasma, with somewhat less emphasis on the latter than before the war. In general, the massive shift of plasma which accompanies the extensive second degree burn produces hemoconcentration which is best met with large amounts of electrolyte solution and plasma. Deep burns produce more severe immediate shock and loss of red cell mass, and here the demand is for large amounts of whole blood and electrolyte and less plasma. Efforts to follow formulae for the administration of the various fluids have led to considerable confusion. Before the War the tendency was to use replacement formulae based upon the hematocrit reading. The Conference on Burns of the National Research Council in 1942 recommended using a surface area formula instead of the hematocrit reading, and at this time Harkins recommended a liter of plasma and an equal amount of salt solution for each 10 per cent of the body surface involved. Cope and Moore<sup>21</sup> used a surface area formula calling for 75 cc. of plasma and 75 cc. of non-colloid-containing electrolyte solution for each 1 per cent of the body surface burned. They developed other formulae on the basis of interstitial space expansion but emphasized the need for careful checking therapy with continuous observations on renal output. Other observers believe that following such formulae will tend to overtreat the patient and may place a dangerous burden upon the circulation and that more emphasis should be placed upon whole blood administration. While there has been at times advocacy of administering massive amounts of fluid during the stage of oliguria or anuria due to renal blockade, the present trend is more conservative.<sup>18</sup> In the light of present knowledge it seems wise to guide fluid therapy on the basis of careful blood observations, renal output and clinical acumen.

*Control of Infection and Protein Depletion during the Later Phase of Burn Treatment.* It seems proper to separate late treatment of burns from early treatment. Failure to do so has led to considerable confusion in the literature. For the first few days following the burn treatment is directed toward life saving meas-

ures, treatment of shock, maintenance of fluid balance and blood volume, replacement of damaged red cells and plasma protein and avoidance of contamination and tissue edema at the site of the burn. Later the problem consists of management of a necrotic wound that is potentially or actively infected while maintaining the patient in a good nutritional state. Superficial burns pose no problem since they are healed within two or three weeks irrespective of the type of dressing employed, provided gross contamination is not permitted. But when the deep layers of the skin are partially or completely destroyed over a large area of body surface, the possibilities of infection, tissue protein depletion and anemia are great. It is often erroneously assumed that a wound produced by burning is free from infection because it was carefully cleansed at the time of initial treatment and the integrity of the original dressing has been undisturbed since that time and because the patient has been receiving antibiotics, sulfa drugs or both. Too much emphasis has been placed upon the dictum that the initial burn dressing should be left in place for a given number of days. Some surgeons have misinterpreted this dictum to the serious detriment of the patient by leaving in place for days a dressing which was obviously enclosing an infected wound. As a case in point, we recall the case of a young soldier who was transferred to our overseas general hospital desperately ill from a severe burn. He had become toxic on the fifth day and ran a temperature elevation of from 41 to 41.5°C. for several days, during which time he was comatose. His initial dressing had been left in place because "instructions were to leave the first dressing on for ten days." During the interval of marked hyperpyrexia he developed an aphasia and paresis of the right arm which persisted long after the burns were entirely healed.

Significant temperature elevation after the third or fourth day almost always means infection at the site of the burn and appropriate treatment is to be instituted promptly. Just what constitutes appropriate treatment finds very little agreement among authors in the literature. Some of the recommended measures are: (1) to continue vaseline pressure dressings, giving penicillin parenterally; (2) penicillin locally; (3) saline compresses; (4) tub baths; (5) surgical débridement followed by skin graft;

(6) continuous Dakin's solution until ready to graft skin and (7) pyruvic acid. It is important that a method be used which will get rid of slough and minimize bacterial flora in the shortest possible time in order that spontaneous healing or skin grafting may be completed

TABLE I  
EFFECT OF WOUND TREATMENT UPON BACTERIAL COLONY COUNTS

Days of Treatment	Method of Treatment	Colony Counts on Wound Washings	Appearance of Wound
3	Dry dressings	Innumerable	Little slough
3	Dakin's solution	40	Clean
2	Physiologic saline	Innumerable	More exudate
1	Dakin's solution	50	Clean
3	Dry dressings	Innumerable	More exudate
1	Petrolatum gauze	Innumerable	Thicker exudate
2	Dakin's solution	150	Clean
6	Sulfa and petrolatum	2,000	Much exudate
3	Dakin's solution	100	Clean

promptly before the patient's healing powers are impaired by protein depletion or anemia.

Penicillin or sulfa drugs are relatively ineffectual either locally or systemically in the presence of slough or exudate as shown by bacteriologic studies. (Tables I and II.) Table I shows the range of variation in bacterial colony counts on wound washings from a large granulating wound. In each instance 0.1 cc. of the 30 cc. of physiologic salt solution used to flush the granulating surface was plated with 5 cc. of blood agar. The column at the left indicates successive days of treatment. "Innumerable" indicates that colonies were too numerous to count. Colony counts were also checked with direct bacterial counts on smears. These generally ran parallel to the colony counts except when petrolatum gauze in contact with the wound stimulated so much cellular exudate that the direct smears were useless. The observations recorded in this table and in Table II are typical of many made in the course of wound studies. Tub baths are somewhat more effective but are not always well tolerated by severely burned patients. Pyruvic acid as advocated by Connor and Harvey<sup>19</sup> is difficult to prepare, painful to apply and impractical for large surfaces although it dissolves slough

rapidly. Surgical débridement, as recommended by Allen,<sup>4</sup> is an attractive method and in his hands has been very effective. He examines the wound under anesthesia on about the tenth day, excises the necrotic slough and applies a sterile, fine mesh gauze dressing; he then

TABLE II  
EFFECT OF WOUND TREATMENT UPON BACTERIAL COLONY COUNTS

Days of Treatment	Method of Treatment	Colony Counts on Wound Washings	Appearance of Wound
3	Dakin's solution	600	Clean
3	Penicillin locally*	1,800	No change
3	Penicillin locally and intramuscularly	10,000	More exudate
3	Dakin's solution	250	Clean
3	Dakin's solution	10	Clean
2	Physiologic saline	Innumerable	More exudate
3	Azochloramid†	Innumerable	More exudate
3	Dakin's solution	200	Clean

\* The penicillin solution used contained 20 units per cc.

† The difference in effect of azochloramid and Dakin's solution is explained by the rapid release of available chlorine by the latter and by the stability of the former. Experimental observations indicate that when in contact with human blood plasma *in vitro* Dakin's solution loses 77 per cent of its available chlorine in one hour while azochloramid loses none. Similarly, when Dakin's solution is dripped slowly (3 drops per minute) through a subcutaneous wound, it loses 89 per cent of its available chlorine while azochloramid loses 5 per cent. With rapid flow through the wound (60 drops per minute), Dakin's solution loses 21 per cent while azochloramid loses none.

applies a skin graft two or three days later. The chief limitations of the method are those of size. Very large areas cannot be treated in this manner even with large quantities of available blood. Dakin's solution dressings provide the most generally useful and safe method of treating the large burned surface at this stage. Both experimental and clinical evidence have shown that it dissolves slough rapidly and at the same time reduces bacterial flora of the pathogens to a minimum level. With effective hypochlorite dressings, it is usually possible to get rid of slough and cleanse a wound adequately for skin grafting in from three to ten days. An occasional case with deep slough will require more time.

## IMMEDIATE SKIN GRAFT OF FRESH BURNS

For years circumscribed, small, deep burns have been excised and skin grafted immediately with good results. Several observers, notably Young<sup>16</sup> and Cope,<sup>22</sup> have recently advocated the immediate excision and skin grafting of full-thickness burns. The idea is attractive but impractical. In an occasional instance a full-thickness area of burn of moderate size can be excised and grafted immediately with time-saving and safety to the patient. Observers agree, however, that it is virtually impossible for even the most experienced surgeon to determine accurately at the outset the extent and depth of the burn. The immediate graft must then be done on the basis of a guess which may err either on the side of wasting good skin or not excising enough. It is also quite apparent that for the desperately ill patient already in severe shock the method is quite impractical.

## STATISTICAL DATA

Statistical data on the treatment of burns are meager and difficult to evaluate. In other publications we have summarized figures that were available in the literature.<sup>28</sup> In Table III we have brought our own continuous series of burns up to date. This series started with the ambrine era and ends with the pressure dressing era. The only valid deduction seems to be that during the coagulation regimen the mortality from burns treated under otherwise comparable conditions improved. No significant change in the mortality can be attributed to the pressure dressing regimen.

## ARMY EXPERIENCE

It was hoped that observations made during the recent war would provide material which would be helpful in evaluating burn treatment. This is, unfortunately, not the case. Burn treatment was not standardized in the armed forces until after TB Med. No. 15 made the pressure dressing technic mandatory in the Army, and the available records suggest that no valid conclusions concerning the effect of treatment upon mortality can be reached. Gross mortality figures for burns from the Army for the years 1943 and 1944, computed from samples of significant size,<sup>11</sup> are summarized in Table IV. These figures give an overall mortality from burns of 6.8 per cent for November, 1948

these years and a mortality of 5.2 per cent for non-combat burns. While the latter figure is superficially comparable to figures from civilian hospitals, it is weighted on one side by the high mortality from aircraft burns and on the other side by the fact that the figures also

TABLE III\*  
BURN MORTALITY

Treatment	No. Patients	Deaths	Mortality, (Per Cent)
Ambrine, etc.....	121	17	14.0
Coagulation.....	1153	86	6.1
Pressure Dressings.....	231	14	6.0
Totals.....	1505	117	7.7

\* Continuous series of burns on author's service, St. Luke's Hospital.

include many burns that were not serious enough to require hospitalization. From a sample of 1,532 burns reported by Army hospitals in the Southwest Pacific area, summarized by the author, gross mortality was 2.08 per cent. It is estimated that not more than one-half of these burns were treated by the pressure method.

The army experience brings out the following observations, on the basis of published and personal communications, mostly from the Pacific theater. Several variations in treatment were advocated by individual surgeons. Some preferred plaster to a soft dressing, particularly for patients requiring long evacuation routes. Various applications to the burned surface and methods of cleansing were advocated, there being little unanimity concerning details. The general trend favored simple cleansing under aseptic conditions and a bland type of local dressing. The average comment of surgeons in official reports favored the pressure dressing method. Many, however, had encountered a high incidence of infection among patients so treated by forward units. Some were outspoken in stating that the incidence of infection was definitely higher than among patients treated primarily by tannic acid and silver nitrate, irrespective of the use of sulfa drugs or penicillin. Several reported that patients requiring long transportation in the tropics arrived in poor condition with dressings saturated with foul discharge. Some observers

thought infection was due to inadequate cleansing and asepsis at the time of initial treatment while some believed that the difficulty was inherent in the method of treatment. Some other unfortunate sequelae were recorded which were attributable to misapplication of

tenance of fluid balance and control of infection are probably factors also. It must be recalled, however, that the major reduction in burn mortality took place before penicillin was discovered and sulfa therapy was in its infancy. No figures are available which give any indica-

TABLE IV\*  
BURN MORTALITY

	1943			1944		
	No. Cases	Deaths	Mortality, (per cent)	No. Cases	Deaths	Mortality, (per cent)
Combat.....	751	220	29.3	2,400	816	34.0
Non-combat.....	24,858	950	3.8	35,713	2,416	6.8
Non-aircraft.....	24,374	283	1.1	34,799	578	1.6
Aircraft.....	1,325	887	71.8	3,314	2,654	80.0
Non-combat aircraft.....	1,032	753	73.0	2,674	2,160	80.8
Total cases.....	25,609	1,170	4.6	38,113	3,232	8.5
Overall mortality for these years.....						6.8%
Overall non-combat mortality.....						5.2%

\* United States Army figures published in the Bull. U. S. Army M. Dept.<sup>11</sup>

the pressure principle. Several instances of radial or common peroneal palsies and one instance of a Volkmann's contracture were reported from pressure dressings that were too tight. It may be stated that the author has observed similar complications in civilian hospitals.

*Comment.* The interval of time spanning two world wars has witnessed considerable change in the local treatment of burns and marked progress in understanding of the systemic effects produced by severe cutaneous burns. It has witnessed the birth and death of a radical departure in local treatment, with return to the general principle of management in vogue at the beginning of the period. It has also witnessed an appreciable overall lowering of mortality from burns. The reduction in mortality occurred during the era when the coagulation regimen was in vogue and has not thus far been significantly altered by the general adoption of the pressure dressing principle. It would seem, therefore, that local treatment of the burn may have been of less importance than interest which the coagulation regimen stimulated in the burn problem and the benefits which accrued from more systematic treatment. Better treatment of shock, main-

tion concerning the effect of the widespread use of penicillin. It is not to be expected, however, that control of infection will greatly alter mortality figures since the majority of deaths occur during the first seventy-two hours at a time when infection can rarely be considered a lethal factor.

On the basis of present day knowledge the objectives of burn treatment are: (1) To treat shock and hemoconcentration. (2) To cleanse the wound simply and gently and keep it as free as possible from contamination by means of a dressing which also limits fluid loss from the injured surface, limits deposition of edema fluid in the subcutaneous tissues and helps to immobilize the injured part. (3) To maintain fluid balance by introducing water, electrolyte, blood or protein-containing fluid sufficient to meet calculated losses and provide for an adequate urine output. (4) To combat infection at the site of the burn by both local and systemic measures whenever its presence is apparent. (5) To create both local and systemic conditions which will favor the earliest possible closure of the wound with skin of good quality.

There were obvious advantages of local treatment of the burned surface by coagulation, mainly, it was relatively easy to maintain a



clean, dry field for several days after treatment and local fluid loss and edema were minimized by the pressure of the coagulum. A harmless method of coagulating the surface of the burn would still be desirable. Experimental use of inert and impregnated films has thus far been inconclusive. The work of Chase<sup>17</sup> who produced a coagulum with extract of beef aorta offers possibilities but has not yet been used extensively.

Vaseline gauze or other petrolatum base ointments have undesirable features when in contact with necrotic tissue or a granulating wound. It has been shown by the author and others that petrolatum increases wound exudation, which exudate in turn considerably decreases the effectiveness of either sulfa drugs or penicillin. The ideal local treatment for the burned surface is yet to be found.

#### DETAILS OF MANAGEMENT

*Shock Treatment—Fluid Balance.* An immediate evaluation of the patient should include the following considerations: (1) extent of the burn, (2) depth of the burn, (3) presence of shock, (4) presence of hemoconcentration.

The presence or absence of hemoconcentration can be determined immediately with reasonable accuracy by means of the copper sulfate estimation of blood specific gravity and conversion to an hematocrit value. This procedure requires but a minute or two and checks well enough with other methods to be practical for making serial observations during the critical stage of the burn. Subsequently, a red cell count, hemoglobin and hematocrit estimations, plasma chlorides, total protein, and non-protein nitrogen determinations are made: these are repeated as found expedient. Even in the absence of the latter tests, however, the copper sulfate specific gravity estimations and careful clinical observation are adequate guides to therapy.

After the brief preliminary survey of the patient a well coordinated plan of treatment is followed out. It is essential that the plan be simple and that it be carried out without delay and without interruption.

The immediate possibilities for consideration are as follows:

1. If the burn is of moderate extent and depth and the patient shows no evidence of shock or hemoconcentration, local treatment of the burn is carried out at once without intra-

venous therapy, depending upon oral administration of fluid.

2. If the burn involves a large surface area but mostly of second degree depth and especially if there is already evidence of hemoconcentration, intravenous administration of plasma is begun at once. Plasma, 500 cc. to 1,000 cc., are given within the first six hours and an equal amount of Ringer's solution or physiologic salt solution is also given preferably simultaneously. If hemoconcentration increases in spite of therapy, the same quantity of plasma and electrolyte solution is administered later in the day. The patient is encouraged to take as much fluid by mouth as is tolerated. If the patient begins to vomit during the first twenty-four hours, at least an additional liter of electrolyte solution is given intravenously. Early vomiting is an unfavorable prognostic sign. The total fluid intake for the first day will be between 3 and 4 L. for the average adult of about 55 Kg. The intake for children will be in proportion to weight plus about 25 per cent. The patient is encouraged to take milk or other protein-containing fluid by mouth if tolerated. If later on the first day the patient shows evidence of shock, whole blood is to be substituted for the recommended dosage of plasma.

3. If the burn involves a moderate to large surface area (30 to 60 per cent) a considerable portion of which is presumed to be third degree and especially if the patient is admitted in shock, plasma is started intravenously at once and given rapidly. As soon as cross matching has been completed whole blood is substituted for the plasma and is covered by an equal amount of electrolyte solution. Thus, within the first six to eight hours, the average adult patient will receive approximately 500 cc. of plasma, 1,000 cc. of whole blood and 1,500 cc. of electrolyte solution. If the shock state continues, the blood and electrolyte solution is repeated. Fluids are given by mouth as tolerated. If hemoconcentration supervenes, plasma and electrolyte solution are substituted for whole blood. If the patient continues at shock level at the end of twenty-four hours, similar intravenous therapy is continued, but the prognosis may be regarded as very poor.

4. If the burn is of relatively small size (less than 3,200 sq. cm.) and obviously of full-thickness depth and the patient shows only minimal to moderate shock, plasma and blood



may be administered and the patient prepared for immediate excision and skin graft. At least 3,000 cc. of compatible blood must be available before starting the procedure.

On the second day the intravenous fluid will consist of whole blood and electrolyte solution unless hemoconcentration indicates that plasma should be substituted. The intake should equal or moderately exceed that of the first day. On this and subsequent days the urine output is carefully observed and recorded. The output is likely to decrease on the second and third day and proteinuria and hemoglobinuria may be observed.

If on the third or subsequent day renal suppression appears to approach anuria, it may be helpful to record the hourly urine output with an indwelling catheter in place as suggested by Cope et al.<sup>21</sup> If the hourly output falls below 20 cc. for several hours and is not considerably increased by intravenous administration of 1 L. of 5 per cent dextrose solution, it may be assumed that renal blockade is impending. To attempt to force out the renal blockade at this stage by administering large amounts of fluid intravenously is likely to be destined to fail and may result in generalized edema, circulatory embarrassment and possible collapse. As advised by Coller and associates<sup>18</sup> it is safer to limit fluid intake to that which is required to cover actual losses, combat acidosis when it occurs and "ride out the storm" until the renal tubules begin to function again.

When renal output increases again, the urine output is likely to exceed the fluid intake (usually seven to 10 days after the burn). At this stage there is need for a large fluid intake and dehydration and salt depletion are to be guarded against. An intake of 6 or 7 L. a day may be required to avoid a deficit. The simple bedside urinary chloride estimations of Evans and Van Slyke<sup>27</sup> are of value in determining whether water replacement alone or electrolyte solution is required. The urine chloride estimation is much quicker and often more reliable than the plasma chloride determination.

During the phase of polyuria, anemia and hypoproteinemia are likely to develop rapidly unless replacement therapy is adequate.

*Local Treatment of the Burn.* Assuming that the considerations discussed in the previous section on shock and fluid balance have been met, the following procedures are carried out in order. Each step is carried out quickly and

with minimal trauma. No anesthesia is used except under unusual conditions. It is expedient that all necessary supplies and equipment be centralized on a movable table or cart in order to minimize delay or interruptions.

1. Morphine is administered for pain when indicated, not routinely. It is administered intravenously in order to act quickly and minimize late depressant effects.

2. Under strict asepsis grease or oil are gently removed from the burned surface with an appropriate solvent. The area is then cleansed with plain soapy water (not green soap), then flushed with sterile saline. Small blisters are not disturbed; large blebs are evacuated in the interests of comfort; vigorous scrubbing is not permitted.

3. Strips of fine mesh cotton or rayon gauze are layed over the burned surface, followed by heavy rollers of coarse mesh gauze. A full-thickness sheet of sterile absorbent cotton is applied overall, secured with an evenly applied, snug bandage of cotton or elastic material. If an extremity is involved, it is covered completely. Fingers are padded to maintain position of function. If an elastic bandage is used, great care must be exercised to avoid making the dressing too tight. The term pressure dressing must not be interpreted too literally.

4. Mucocutaneous junctions and genitalia are greased with sterile petrolatum.

5. Antibiotics are not given at the outset unless the patient is to be transported for long distances without constant observation.

*Changing the Dressings.* The time for a change of dressing has been the subject of much controversy. Experience has shown that there can be no set rule. With superficial burns, the dressings may remain undisturbed as long as they are dry and clean and as long as the patient's temperature is normal. The surface will often be healed at the time of the first dressing. With deep second and third degree burns, the dressings are likely to become saturated with exudate somewhere between the fifth and tenth days and the patient's temperature rises. It is to be assumed at this time that infection is present and to leave the dressing undisturbed is dangerous. The method of control of infection may be one of the following: (1) Frequent change of dressings and antibiotics systemically. This method depends upon mechanical cleansing to control infection locally. Frequent tub baths may assist with

the mechanical cleansing but are not always well tolerated by very sick patients and are not practical in the field. (2) Continuous Dakin's solution dressings, with or without systemic antibiotics. (3) Delayed surgical débridement and skin graft as advocated by Allen.<sup>4</sup> (4) Antibiotics and chemical débridement by an agent such as pyruvic acid, recommended by Connor and Harvey.<sup>19</sup>

*Comment.* Frequent change of dressing is adequate when burns are relatively superficial, necrotic tissue is minimal and there is a low grade infection. When slough is deep and infection considerable, however, no generally applicable method has been found as satisfactory as the Dakin's dressing which combines bacterial control with ability to dissolve slough and exudate. Surgical débridement and graft is safe only on exceptionally well organized services staffed by surgeons who are able to operate rapidly and with minimal trauma. Chemical débridement has thus far not proved practical for general use.

Since it is this phase of burn treatment that is most often misunderstood and mishandled, in the experience of the author the following details are appended for emphasis.

*Dakin's Solution Dressing.* The hypochlorite solution must be fresh and of full U.S.P. strength since its bactericidal properties depend upon the available chlorine which is released quickly when in contact with tissue fluid.

The wound surface must be continuously wet with the hypochlorite solution. This necessitates a dressing which is frequently moistened by continuous drip or one in which evaporation is minimized by an impervious covering. The optimum is achieved by means of a heavy dressing of roller gauze, covered with a thick layer of sterile absorbent cotton bandaged on with even pressure and a covering of oiled silk similarly bandaged overall. This dressing is kept wet either by a continuous drip or by wetting it thoroughly with fresh Dakin's solution every four to six hours and again bandaging on the oiled silk cover.

The dressing is changed often enough to get rid of necrotic tissue as it separates, usually every twenty-four to forty-eight hours.

Pain is minimized by protecting normal skin with sterile petrolatum and applying a lattice work of petrolatum or xeroform gauze over the burned area. When the dressing is changed,

it is also helpful to apply the roller gauze that goes next to the wound wet with sterile saline. The entire dressing is then wet with Dakin's solution a few minutes later.

If the dressing is stained green by pyocyanus exudate, it is to be assumed that the Dakin's is below U.S.P. strength or has been improperly applied.

It is essential that a method of burn treatment be used which will prepare the denuded wound for skin grafting at the earliest possible date. Using effective Dakin's solution dressings on an extensive burn, this optimum can usually be accomplished in from three to ten days.

#### MAINTAINING A GOOD NUTRITIONAL STATE

During the later stages of burn treatment if secondary anemia and hypoproteinemia are permitted to exist the wound granulations become edematous, bleed easily—sometimes dangerously—and epidermal growth is arrested. Repeated blood transfusion and a high protein intake are always necessary at this stage. The protein intake should be from two to three times the requirement of the normal individual to compensate for the loss of tissue protein from the large wound. The importance of this requirement cannot be overemphasized. The amino acid preparations now available everywhere are helpful in accomplishing this purpose. A normal plasma protein determination may be misleading in the presence of anemia. Lund<sup>33</sup> and Siler<sup>42</sup> have called attention to the importance of maintaining an adequate vitamin intake, especially that of ascorbic acid, a dosage of 1 Gm. or more a day of the latter being recommended.

#### SKIN GRAFTING OF LARGE BURNS

When the patient has survived the early critical stage of the burn, every effort of the surgeon is directed toward closing the wound with satisfactory skin at the earliest possible date in order to minimize the threat of nutritional deficiency, late infectious complications and the crippling effects which accompany excess scar formation.

The type of graft should be applied which will cover the denuded area rapidly, with least threat to the life of the patient and with the best chance of providing a permanently satisfactory surface. Small, deep (pin point) grafts almost never meet these requirements and deface donor sites inexcusably. Large sheets of

split-thickness skin, on the other hand, are cut rapidly from almost any donor site and can be applied with a high degree of success. The resulting skin surface is usually permanently satisfactory.

The granulating bed of the wound is shaved down to normal subcutaneous tissue before applying the grafts. The grafts will take on a thick bed of granulations, but the resulting skin will be deformed by the underlying fibrous tissue. Applying the grafts to subcutaneous tissue of normal texture insures smoother, even skin.

When the denuded area is large and the donor sites are limited, the sheets of skin must be stretched to the limit, both figuratively and literally. The life of the patient or the function of a limb may depend upon early closure of the wound. By tacking large sheets of skin together and suturing them to the wound margins under stretch, maximum coverage is obtained with minimum hazard of failure.

If the wound is completely covered by the grafts, either wet or dry dressings may be used satisfactorily. If, however, there are open granulations adjacent to the grafted area, the margins of the latter are protected by keeping the dressings wet with Dakin's solution for several days after the first twenty-four hours. Penicillin, given systemically both before and after the graft is performed, definitely increases the percentage of perfect takes.

It is just as important to maintain blood and protein balance after the graft as before.

#### MANAGEMENT OF BURNS IN THE ARMED FORCES

Burns represented a relatively small percentage of all casualties in World War II. Atomic warfare presents the probability of a larger percentage of burns in the event of future conflict. Burn treatment during the past war was not well organized. It would be fair to state, however, that the confusion that existed in the medical services of the armed forces was shared by the medical profession at home. In retrospect, it seems likely that the shock phase of treatment was fairly well carried out during the latter part of the war and at least some of the local, primary treatment of the burned surface was well done. The final stages of reconstruction to correct burn deformities was exceptionally well carried out on special plastic services. The weakest link in the chain seems to have been the management

of the infected wounds resulting from deep burns.

Experience seems to indicate that the overall treatment of burns has been best in hospitals where groups of surgeons have formed teams to coordinate the treatment. The same principle should be applicable to our military forces.

The simple outline of burn management which has been described on the preceding pages could be adapted to field conditions in any overseas theater of operations with ease. The primary treatment could be handled admirably by a shock team in any forward unit. The badly burned patient should, of course be retained in the forward unit until stabilized, along with other categories of major injuries involving shock. By the third day it will usually be safe to transport the burned patient by air to a fixed installation where he could be under the supervision of an experienced burn team composed of surgeons selected for their understanding of wound management and for their skill in grafting large wounds. The patient should then remain with the burn team until his wound is closed. When an evacuation line required more than two or three days of transportation from the forward unit to the burn team, evacuation should be by hospital ship where the patient can be under the observation of a surgeon of similar training and experience to those composing the burn team. It is believed that such a plan would considerably reduce the morbidity from burns, it might reduce the mortality appreciably and it would certainly enhance the patient's chance of making a complete functional recovery.

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# TRAUMA RESULTING FROM ATOMIC EXPLOSIONS

CAPTAIN R. P. PARSONS, M.C., U. S. NAVY

*San Francisco, California*

IF two atomic bombs can kill 80,000 people and injure another 80,000, if it is still remotely possible that they will fall again on our own land or elsewhere, perhaps in greater numbers and with greater power of destruction than was the case three years ago in Japan, then it is proper that this Society hear something about the trauma caused by these explosions.

Let us form three concentric circles at half-mile intervals so that the smallest has a radius of one-half mile. The center of these three circles is the zero ground point, that is, the point directly below the point of the atomic explosion in the air. This division is, of course, quite arbitrary and the generalizations as to trauma in the three circles are not strictly accurate. In all of the five explosions for which data have been published many peculiar things happened: there were local points of greater destruction at greater distances and some points of less damage at lesser distances, but in general the inverse square law as to decline of force (and damage and trauma) with distance increase applies, and this rough division of distances is a very convenient one in which to group the types of trauma.

In the small center circle there will be practically no survivors. The people in it will be, so to speak, killed three times over—(1) by the direct blast or by being struck with flying objects, by being crushed in collapsed buildings, by being flung against buildings, walls, trees, etc.; (2) by burns, direct burns from the heat of the explosion or by being caught in buildings set afire by the heat of the explosion; (3) by radiation. In the middle ring (from one-half mile to one mile from the zero ground point) there will be (1) much fewer blast injuries; (2) the flash burns will be just as numerous but mostly non-fatal although deep enough to produce a great crop of keloids a few months later; (3) there will be thousands of deaths from radiation as well as thousands of non-fatal radiation victims. In the outer ring (one mile to a mile and one-half) the injuries will be limited mostly to non-fatal flash burns.

Some mild flash burns will occur at distances even beyond the two-mile zone.

Most of the severe and fatal blast injuries will be from falling and flying debris. Actually there were, both in Japan and among the animals at Bikini, comparatively few cases of ruptured viscus and in Japan, at least among the survivors, even the occurrence of ruptured ear drums was rare. Evidently the earlier estimates of this type of trauma were quite exaggerated.

The flash burns will show some very queer patterns. This is an instantaneous type of exposure. White cloth will protect better than black cloth so that the print patterns of women's clothing will be burned on their bodies. Among some allied prisoners of war at Nagasaki, working two to three miles from the explosion, we saw cases in which their names had been burned onto their chests or backs because the names had been stenciled in black on their white undershirts. Clothing is an excellent protection against flash burns at distances of one to three miles from the explosion. The light and heat of the flash are so intense that it is almost as though a piece of the sun were suddenly transported to this planet. In fact, at Bikini the air burst viewed at twenty miles looked very much like a huge and very rapidly rising sun over the horizon of the sea. Viewed at that distance and through dark goggles so thick that objects cannot be distinguished at three or four feet it is a brilliant flash.

The temperature at the center has been estimated at a million degrees centigrade. At two miles the Japanese physicists and chemists estimated the temperatures to be from 3,000 to 9,000 degrees centigrade. These estimates were based on the melting and charring of certain substances at that distance. Telephone posts were charred and fires were started in some areas at distances beyond two miles. The skin burns varied (according to distances from the explosion) from mild erythemas to serious third degree burns followed by the usual granulating wounds, contractures and keloids.

The pathology of ionizing radiation has become a very large subject in the last three years and can only be touched on here. All of the radiation lesions seen in the Bikini animals have been reproduced later in other animals of the same species by x-ray alone. The immediate radiation fatalities, occurring in Japan in the inner circle, were doubtless from neutrons while those at greater distances and with symptoms appearing after an interval of one to several days were the result of gamma ray exposures. The alpha and beta radiation injuries can only occur as results of underwater explosions when the victims are sprayed or come in contact with objects that have been sprayed with water containing the fission products of the explosives. In the air bursts these products rise quickly in the atomic cloud to heights of many thousands of feet and are dispersed in the stratosphere, except in the most unfortunate circumstance when a heavy rain fall catches the atomic cloud before it has dispersed and may carry to the earth a rain of death drops in the form of intensely radioactive fission products.

The chief trauma from radiation is in the hematopoietic and lymphatic systems. Aside from those dying in the first day or two, the highest death rates will be seen in the third and fourth week. The prognosis for those entering hospitals with radiation sickness after the fourth week will be increasingly favorable. The clinical course will include nausea, malaise, anorexia, diarrhea, all the signs of extensive hemorrhage (into stomach, bowel, kidney), purpura and epilation. The laboratory findings will include leukopenia, anemia and increased bleeding time. The one quick, early and reliable finding is leukopenia, the extent of this drop being a valuable prognostic index. In severe cases the count goes below 1,000 and in fatal cases may even reach zero before death occurs.

The only good prevention is to be at a distance of at least five miles from the explosion. With the later bombs, this distance may have to be increased. No public information has been released on this point. At much shorter distances survival or even complete protection may be possible under ideal shelter conditions.

As to treatment of radiation victims this of necessity becomes a mass problem rather than any individual case problem. It will require highly organized and well trained rescue teams

and a catastrophe hospitalization program that must include an enormous blood bank system. Whole blood is the only effective agent yet known for life saving purposes in radiation sickness.

Casualties of all types will be found in an area of 8 to 10 square miles after an air burst and about 15 square miles after an underwater burst. The water spray actually covers an area of some 30 square miles but half of it will be out over the lake or outer harbor where there will be few or no people. Rescue squads can enter the air burst area almost immediately after the explosion but, following an underwater burst, the problem becomes very complex—much too involved for a discussion of this length.

#### DISCUSSION OF PAPERS BY DRS. LIVINGSTON, DEARING, GLOVER AND PARSONS

VINTON E. SILER (Cincinnati, Ohio): Dr. Glover has given a very fine discussion of the present status of burn therapy and I would like to re-emphasize one of the points which he made in his paper, namely, early application of skin to the areas of total skin destruction. It seems to me there are four reasons for the delay of early skin grafting:

The first one is that wounds produced by a burn are frequently extensive and because of the poor general condition of the patient from this type of trauma grafting is delayed.

The second reason is that the area of total skin destruction is composed of sloughing tissue which is difficult to remove and grafting cannot be done until the wound is adequately prepared. There are essentially two methods now available for the removal of this slough, these being physical and chemical methods. The physical methods have been discussed by many observers throughout the country during the past five years. One of the first to discuss this method of removal of sloughing tissue was Young; however, Cope, McCorkle and others have helped to popularize this technic. In this procedure the patient is usually given a general anesthetic and the area of slough is actually excised down to and often including normal tissue. The general condition of the patient is usually good; however, this factor governs the extent of débridement and also the optimum time for it. If the area of sloughing is extensive, this procedure is usually best done in stages. Grafting has been done both immediately and delayed after this procedure.

A chemical approach to the removal of sloughing tissue is sound and ideal. We have been interested in this problem for many years and during the past year particularly. I cannot go into all of the details here except to say that the ultimate answer to this



problem may lie in the realm of proteolytic enzymatic activity. During the past twelve months in the laboratory we have been able to remove sloughing tissue on a dog, created by a heat burn, without apparent damage to living cells. The most rapid removal has been twenty-eight minutes; however, the average time has been between one and two hours. At present, working with Drs. Logan and Tytel in the Department of Biochemistry, we have found a collagenase which is very active and at least fifty times stronger than the proteolytic enzymes of pancreatic substance. The problem confronting us at the present time is to find an enzyme which will attack the keratins of the skin to the same degree that the collagens are destroyed. I am sorry to say that at the present time we have not solved this problem.

The third reason for delay of early grafting is frequently due to severe infection of open wounds. I agree with Dr. Glover, as I am sure others do, that Dakin's solution is the best method of bringing these infected wounds under control. We have found that by using Dakin's manifold tube in a semipressure dressing and leaving the dressing in place for some three to five days we have been able to control infections of these wounds much better. In this instance the solution is instilled to the manifold tube every three to five hours.

Last, but certainly not the least of the four reasons, is delay in grafting because of the indiscriminate procrastination on the part of the surgeon. We have found it particularly true in our own hospital that residents are more apt to be interested in doing major surgery such as subtotal gastrectomy, splenectomy or other similar operations than they are to concern themselves with the early closure of large open wounds. I am convinced that this type of procrastination should be corrected.

GROVER C. PENBERTHY (Detroit, Mich.): The history of burns as Dr. Glover has reviewed it is most interesting, and all of us in the past thirty years have seen great changes and great improvements but we still believe that there is room for more improvement.

With the mortality figures as he has given them, prior to the tannic acid or coagulation period (and he has compared them with the present type of therapy), they show something which I do not think he emphasized too strongly: that it does not all depend on local treatment. We do appreciate and know that a burn is a surgical wound and must be treated and the principles of good general surgery must be instituted, but it shows from the mortality figures reported in the various clinics that it is the general systemic treatment which after all, in addition to the good surgical local treatment, helps to maintain our low mortality.

Dr. Glover mentioned the fact that fluid therapy must be based on careful blood observations, the renal output and the general acumen of the indi-

vidual surgeon. That is a very sound principle to follow in the management of this type of lesion.

He has referred to Dr. Collier and his associates in their work in limiting the amount of fluid that must be given parenterally. Simply maintaining what is actually lost has been proven by Dr. Collier and his group to be all that is necessary. They emphasize, however, how important it is for oral intake in preference to the intravenous route, and that is something I am sure all of us will support as an idea in maintaining fluid balance.

The teamwork, as Dr. Glover has said, is of great importance, and I am sure with what experience we have had in the various clinics we are ready today to meet the problem of burns with a team fully equipped to take care of that burn patient. It maintains the interest of the house staff. Dr. Siler said they would rather do gastric resections and other major operations. It falls to the attending staff I think to stimulate the resident and intern staff to maintain their interest in this subject, the treatment of burns.

With that I am sure we can maintain the low mortality we have, and for the future still bring the mortality down to a much lower figure.

HERBERT M. ELDER (Montreal, Canada): Dr. Glover mentioned the transitional period through which he and we went, and I had the opportunity of seeing part of that. In 1939 we were all indoctrinated with the idea of the coagulation treatment of burns. That continued in 1940, and 1941 for a time. I had the opportunity then of seeing McIndoo's work at a burn center established by the Royal Air Force where most of the severely burned pilots of the Battle of Britain were sent. They were all very similar burns.

The Spitfire at that time was about the only plane we had, and at that time we did not have a self-sealing tank. The tank was across the cowl in front of the pilot. The consequence was that if that tank were hit by an incendiary the pilot had just about ten seconds to "hit the silk," and he was always badly burned during those ten seconds.

It became known as a pilot-officer burn—both hands, the face and the thighs. McIndoo set up the first of the various units which had a good deal to do with the change in that treatment. He turned to the continuous bath treatment. Originally one saw these people treated with tannic acid, particularly on the moving parts. If you have ever seen a badly burned hand treated with tannic acid, with the knuckle bones showing white through the scar, you will never want to use tannic acid again. We had to take tannic acid out of our tank first aid kits. The anticoagulant on any moving part was definitely taboo. The saline bath came into vogue and now we are in the pressure dressing era.

I would like to emphasize that the pressure dressing cannot be applied by any neophyte; it is



not a simple matter and it is not something that is just pushed on the patient. It has to be very carefully applied. The pressure has to be even, else one will get extremely bad results. One of the previous speakers mentioned the overemphasis of pressure leading to ischemia, Volkmann's paralysis and so on.

Secondly, from a purely military point of view the pressure dressing is not always a good thing for the transport of patients because sometimes they are placed in attitudes which produce creases, and those creases will sometimes produce so much pressure as to produce necrosis.

I think before going overboard on pressure dressings we have to consider some of those points; we should use the pressure dressing with a good deal of respect and not consider that it is the be-all and end-all.

STEPHEN A. HUDACK (closing): I believe I express the sentiments of the members of this Association when I thank the individuals who have given papers on this symposium on military surgery. I would like to emphasize that I have known all four of them personally for some time.

I worked with Dr. Livingston on the west coast, collaborating with him on some of the complex reconstruction problems which involved both injury to the peripheral nerve system and the motor skeletal system.

Admiral Dearing packs behind his discussion the shoestring brigade. He was the senior medical officer responsible for evacuation of troops serving with the Third Fleet with Admiral Halsey in the South Pacific force, and I am sure in the early period he labored under many disadvantages, being told sometimes that bullets and beans were more important than something else.

Dr. Robert Parsons is a gentleman of many accomplishments, not chief of them being that he was the senior medical officer of the U.S.S. *Haven*, which was actually the first ship to hit Japan, and they did their observing at Nagasaki about one month after the explosion of the bomb. Their ship was the one to evacuate the war prisoners and screen approximately 10,000 of them, of which 1,000 were taken aboard. Officially he was an

observer on the radiologic safety ship in the observations at Bikini during the atomic bomb tests.

I believe the wide experience these speakers carry should have some weight in any deliberations that this body may think fit to carry through in any form of recommendations.

ARTHUR H. DEARING (closing): In the early days of the war in the South Pacific there was some dissension and feeling of jealousy between the Army and the Navy. It has been my feeling on the subject that when the reserve officer comes on active duty we should no longer speak of him as a reserve and we should not have this discrimination or this talk about regulars and reserves.

I have heard of Dr. Livingston's unpleasant experiences, and I know that there are many other medical officers who are now on inactive duty and some who are still on active duty who had unpleasant experiences during the last war. They were bound to! You will always find people who will be unpleasant to other people in any walk of life. It does not hold true particularly of doctors, I am sure.

Dr. Livingston survived those unpleasant experiences and I am sure his paper does not represent bitterness on his part in speaking of them. It is an honest attempt to lead all of the medical profession into some line of planning which will be beneficial to the whole country in case of another war.

People talk about the officers in uniform being warmongers. We are not warmongers; we do not want war but we have got to face the possibility, and I am sure that after hearing what Captain Parsons has said about the possibilities of atomic warfare and the fact that we realize that if there must be another war this country will not be immune as we have been in the past but that it will undoubtedly mean war on our shores, then the planning for medical defense and the planning for care of casualties is going to be a problem, and a problem for the entire medical profession. It cannot be left to the military or the naval services or even to the Office of Civilian Defense. It is a problem for every one of us to think about before war comes.



# NATURE OF TRAUMA IN ATOMIC WARFARE

AUSTIN M. BRUES, M.D.

*Chicago, Illinois*

IT may appear remarkable for an internist to speak on the subject of trauma but the development of the atomic bomb has resulted in a form of mass physiologic trauma with which most of us were hitherto unfamiliar. In addition to this many of the more familiar forms of trauma are attendant upon the explosion of the bomb.

Our attention was first called to the atomic bomb because of its explosive force which exceeds that of traditional explosives by tens of thousands of times. Trauma to individuals in the area blasted by the atomic bomb includes injuries by flying glass and falling beams, etc., which are seen in the wake of any high explosive or similar major accident. The traumatic effect on structures by the atomic bomb of the style which was used at Hiroshima and Nagasaki is, however, unusual in certain respects. For example, at the Nagasaki bomb center one sees small concrete buildings which appear to have been crushed by a single blow from the direction of the bomb. The Nagasaki bomb was set off in an area of military importance from all points of view halfway between a large steel works and an ordnance plant some distance from the center of the city and around a mountain so that the major part of the city was spared. Between the steel works and the torpedo works which were about a mile apart a civilian community of some size and the Nagasaki Medical School and Hospital were located. I mention that to bring home the fact that in striking for definitely military objectives in the past war and no doubt in wars of the future the general population will be involved in large measure.

The Nagasaki Medical School was a few hundred yards from the point above which the bomb went off. The inside of the building was largely burned out. Less than half of the inhabitants of the building survived and one of the two tall smoke stacks was left inclined away from the bomb center. One of the professors of the Nagasaki Medical School who was suffering from chronic myeloid leukemia and had not been responding very well to radiation therapy

enjoyed prolonged remission as a result of the radiation received at the time of the blast.

At one of the Shinto shrines near the medical school one-half of the traditional stone arch was blown away leaving the other half balanced precariously and the solid stone lantern, lighted at times for the spirits of the dead, was moved over several inches on its pedestal. This shows the effect of the blast wave transmitted through air. A nearby large tree, though still standing, was dead as a result of the heat. In many places, particularly in the Hiroshima bomb field, one can see charred structures in which unburnt areas represent the shadows of leaves or plants and sometimes of human beings. The charring occurred instantaneously from thermal radiation; the shadowing objects were destroyed at once or blown away. From this thermal trauma burns of all degrees resulted, many of which were followed by keloids. These appear on only one side of the body and avoid protected areas; hence, they can be distinguished from those resulting from flash burns. We are told that keloids occur more often in scars in negroes than in white individuals; also that these lesions are more common in wounds which are contaminated or are secondarily infected. The reason for their extremely high frequency among Japanese after atomic bomb burns is a little uncertain, but of the late effects of the atomic bomb on men, probably the most noticeable which is seen after a year or more is the presence of keloidal scars in a large proportion of the individuals who were exposed. This is true to such an extent that they are a common sight on the streets of Hiroshima and no one is thought to be unusual if he bears keloidal scars.

At the moment of explosion the atomic bomb gives off intensely almost the entire spectrum of electromagnetic radiation including visible light. The Japanese colloquial term for the atomic bomb is "bright light." Radiant heat and ultraviolet light are also given off. Individuals who were ten miles from the experimental atomic bombs felt a wave of fairly intense heat momentarily on the exposed parts

of the body. How much ultraviolet light has to do with the late lesions is uncertain; evidence indicates that this is due to a nearly instantaneous, very intense wave of infra-red radiation or radiant heat. Studies have not yet indicated what the racial susceptibility of the Japanese to keloidal reactions is relative to our own. The response to an identical physical stimulus can be seen where numbers of persons were near the same place at the time of detonation. The degree of scarring or keloid formation varied widely between individuals; in some groups receiving the same exposure the range of susceptibility varied from extensive keloids to no visible scarring. We must remember that patients were treated under very primitive conditions because of the general disorder which prevailed, so it is almost certain that the majority of these lesions became infected and remained infected over a considerable period of time.

In general treatment of keloids has been quite unsatisfactory. Surgical removal often results in recurrence. One patient who was treated surgically for keloids of the legs below the knees had pinch grafts taken from the thigh and the area from which the grafts were taken showed multiple keloids where skin was removed from that area. This patient had a scar from an earlier operation which healed without a keloid. One treatment which has been recommended for keloids is x-ray therapy. There has been a natural reluctance to use this on the skin of those individuals who were exposed to the atomic bomb although I believe that most of the patients were far enough from the bomb so that the dosage of radiation they received from that source was relatively unimportant.

Another effect of the heat was to set numerous fires and one, therefore, can see in the bombed areas of Nagasaki and Hiroshima a picture very similar to that seen in other Japanese cities which were bombed with incendiaries where great areas were burned out. I mentioned the fact that bomb fields were the scene of great confusion from medical and surgical points of view immediately after the bombs fell. It is of some interest to see the conditions still prevailing. For example, due to stringent rationing it has been almost impossible to solve the problem of feeding patients in the hospital. It has been necessary to require that the families of patients bring in their ra-

tions, which are prepared at home, and feed them to the patients. In a typical ward in one of the better hospitals eighteen months after the war was over we saw patients' meals being prepared over hot charcoal in the ward by several members of their families.

The confusion immediately after the bombing is difficult to imagine. Besides the forms of injury mentioned before, radiation disease is a new and peculiar form of trauma which has attracted special attention and was soon called "atomic bomb disease" by the Japanese. Radiation from the bomb consists of gamma rays which are entirely equivalent in their effects to x-rays and neutrons which, qualitatively, are also quite similar to x-rays except that they may also induce radioactivity in many normal elements. Induced radioactivity was an insignificant part of the total radiation. Acute radiation sickness is the result of exposure to these energies which are essentially the same in their effects as total-body x-ray.

Soon after the exposure to atomic bomb radiation an initial response occurs which is quite similar to that after a large dose of total-body radiation or a somewhat larger dose of localized radiation to the abdomen in patients who are being intensively treated. One sees vomiting and depression in blood pressure which may be due, in part at least, to stimulation of the parasympathetic system. This passes off within a few hours. After this the radiosensitive tissues and cells are atrophied and destroyed. The blood-forming elements, bone marrow and lymphatic tissue atrophy rather soon. Intestinal mucosa, which is also a tissue of rapidly dividing cells, suffers destructive lesions and ulcers appear. The gonads are atrophied; hair falls out and various other pathologic findings are seen but those are the ones which give the most prominent visible phenomena. When all these things occur, the first visible result is a decrease in the white cell count. Patients are innocent of any impending disease; they are apparently healthy when the transitory phase of acute radiation sickness has passed. Therefore, many individuals who were exposed to bombs and who may or may not have suffered temporary debility went to other places.

One visitor to Hiroshima returned to Tokyo and after a few days became acutely ill. She had petechial hemorrhages under her skin, bloody diarrhea and fever. All of the following

were secondary effects of destruction of the radiosensitive cells: the hemorrhagic diathesis resulting from the destruction of the mast cells which released heparin into the circulation and from disappearance of platelets from the circulation; infection from the lesions in the intestinal mucosa and the failure of white cell formation. Other factors in the radiation syndrome no doubt remain to be understood. The patient died of acute radiation disease approximately two weeks after the bombing having, in the meantime, moved around quite freely. Thus we have the picture of a patient who is apparently perfectly healthy and then, while going about his business succumbs to the delayed effects of trauma to certain radiosensitive cells.

Other patients who recovered from the acute phase developed a subacute state characterized by aplastic anemia. Red cells remain in circulation much longer than white cells; therefore, anemia develops slowly over a period of weeks. At the time when the first American expedition went into Japan almost all of the patients with fatal acute radiation sickness had died and the chief residual clinical picture was one of aplastic anemia, some of which recovered.

There is also the question of sterility. This is produced by a lower dose of radiation in the male than in the female but is usually temporary and as far as available information goes most of the Japanese males who were rendered sterile by exposure to the atomic bomb and who survived the amount of total-body radiation recovered their fertility within a few months. Much of our information has been derived from vital statistics at Hiroshima. The fact that for a period corresponding to two months after the bombing the birth rate dropped and then rose again might be due to the temporary sterility produced and, on the other hand, might be due largely to the general confusion which resulted from the bomb.

One small area some distance from Nagasaki which was shaded from the bomb by a mountain received ground radioactivity from uranium fission products deposited upon it. This was a very small proportion of the total radioactive material because the bombs were carefully set off at such a height that the fission products were carried up into the higher atmosphere. We know from the second Bikini experience that it would be possible to set off a

bomb under water or under other conditions so that the fission products would be trapped near the ground; in that way at least the equivalent of thousands of tons of radium would be scattered on the ground. This would institute a late traumatic effect which is no longer in any sense acute but which can be the cause of total-body radiation of persons coming into the area later, picked up by individuals in the area. These fission products can also be taken into the body and after absorption act as radium does. If they are carried to the bone, as many of the more abundant fission isotopes are, the eventual end result is destructive lesions in bone and malignant bone tumors. These hazards did not exist in the Japanese areas due to the very small (although measurable) portion of the radioactive material involved.

The most delayed effect of the atomic bomb about which there has been much speculation is the genetic result of induced mutations. There is no reason to believe that any immediate deleterious effects have occurred. Available vital statistics indicated that in the year and one-half after the atomic bombing, of Hiroshima there were for the most part no abnormally born children. Reports were obtained of two anencephalic fetuses during that period and also of two babies covered with hematomas who were born of mothers suffering from acute radiation sickness soon after the bombing. There is no doubt that genetic changes in later generations, due to recessive mutations, will occur as a result of radiation in a slightly higher proportion than normal. There is a great deal of doubt, however, as to whether the normal incidence will be sufficiently increased to be visible regardless of the completeness of the statistics because the effect will be relatively small. Mass sterilization, although a possible solution to the impending catastrophe of world overpopulation, also will probably not be significantly effected by the atomic bomb.

I am going from the familiar and, to most of us, the commonly-thought-of types of trauma to a larger field. It seems appropriate to discuss the psychic trauma to individuals and the social body in connection with this subject.

It was, in fact, recognized by the Japanese scientists almost at once that the Hiroshima disaster was caused by an atomic bomb. One physicist was given six months by the army to

develop one and politely declined this impossible order. He was then asked how Japan could be defended against atomic bombs in the future, and replied, "That's very easy. Just keep airplanes from flying over Japan and then you will be sure that no airplanes with atomic bombs will fly over Japan." Three hours after this information was given to the chiefs of staff, surrender was agreed upon. Whether other factors influenced this decision is, of course, not known.

A few comments are in order about the essential difference between the atomic bomb and the ordinary types of warfare. It certainly is not a matter of mechanical trauma, burns or radiation although the latter, which is a very interesting characteristic of the bomb, deserves special attention. The really novel feature of the bomb from the strategic point of view is that when it strikes, a large area is immobilized. I think our experience with local bombing by high explosives dropped here and there even in saturation bombing is that there is a recovery period. People can get out or in and things can be moved around.

In the case of the atomic bomb the problem is somewhat different in that a large area is wiped out instantaneously and in the case of both Hiroshima and Nagasaki hospitals were immobilized at once all over the cities, a large number of the doctors and nurses were killed or put out of useful circulation, water mains were broken, communication was completely interfered with and there was no way of getting into the centers. Thus, the army pilot who flew from Tokyo to Hiroshima to investigate why the radio station had gone off the air and other communications were broken found a city surrounded by a circumference of flame two or three miles from the center of town and was unable to get in. A few people managed to drag themselves through the flames, and these stragglers turned up at Kure, thirty miles away, telling a remarkable tale to listeners who had only seen the bright flash in the sky.

A situation in which an entire region is put out of commission and in which it is impossible to get around is one which has not been seen in its ultimate state of development in past warfare where destruction occurs gradually and one area recovers as another one goes down.

For this reason in particular we must plan now for a civilian defense organization able to assume new responsibility hitherto unnecessary. It will have to learn in advance of a catastrophe how to operate under conditions of great and sudden civic disruption and must have the equipment and knowledge to determine the importance of such ground radioactivity as may be encountered. For the residual radioactivity of a bomb blast set off in water might be enough to require rapid evacuation or it might be as harmless as that on a luminous watch dial or that which was deposited near Nagasaki. In the latter instance the panic engendered in the population might be in itself the major problem. Rumors regarding possible radioactivity at dangerous levels in Japan, some of which originated in this country, still persist among the Japanese. Problems of future war and most particularly of atomic warfare will find one essential answer in the better education of specialists and the public alike to an objective appreciation of possible situations which may arise and to the development of a civilian defense organization which not only is equal to the problems of the past but can apply foresight and wisdom to the problems of future war.

In closing I should like to mention briefly the treatment of the radiation syndrome. Much of the treatment of radiation sickness is very similar to the general non-specific treatment of traumatic conditions. Patients will also have been subjected to burns and mechanical trauma as well as radiation. The use of plasma and whole blood and antibiotics will be indicated from all points of view. There are certain specific agents which will help in maintaining the life of individuals who have been heavily radiated. Toluidine blue and protamine are known to affect the bleeding tendency favorably and progress is being made in the search for other specific agents. The position of rutin and of adrenal hormones in therapy of the radiation syndrome is questionable at the present time. In general the use of blood substitutes soon after radiation with therapy directed to combating infection when signs of sepsis appear and replacement of whole blood when anemia develops will follow a pattern familiar to the traumatic surgeon.

# MASSIVE EXTRADURAL HEMATOMA\*

JOHN RAAF, M.D.

*Portland, Oregon*

**E**XTRADURAL hematoma remains one of the most deceptive and lethal lesions in the surgical field. The results from timely and well executed surgery are so brilliant and consequences from improper handling so disastrous it seems justifiable to review some of the problems encountered in these cases.

Numerous authors have published the mortality among their patients with extradural hematomas. Pringle<sup>1</sup> in 1938 stated that eleven of his seventeen patients (64.7 per cent) with extradural hematomas died. In another group of his patients, eleven of sixteen (68.7 per cent) who had concomitant extradural and subdural hematomas did not survive. A review of Pringle's<sup>1</sup> cases reveals that many of his patients who had extradural hematomas also had extensive cerebral laceration or injury elsewhere such as a ruptured abdominal organ. McKenzie<sup>2</sup> in 1938 reported a 45 per cent mortality among twenty patients; part were postmortem cases and part surgical. Munro and Maltby<sup>3</sup> published their results in forty-four cases, thirty-eight of which were surgical and six postmortem. Twenty of the thirty-eight surgical patients died (52 per cent mortality). Adding the six postmortem cases to the twenty fatal surgical cases, they had a 59 per cent mortality for the total series of forty-four patients. Woodhall, Devine and Hart<sup>4</sup> in 1941 published the results in 177 cases collected from the literature and stated that the mortality was 56.5 per cent. Gurdjian and Webster<sup>5</sup> in 1942 reported that of thirty patients upon whom they had operated eight died (26.6 per cent mortality). Sartorius and Humphries<sup>6</sup> in 1946 reported twenty operative cases of extradural hematoma with only one death (5 per cent mortality). All occurred in a mining practice among adult South African natives. These authors explain their low death rate by virtue of the fact that the injury in seventeen of the twenty patients was the result of assault and therefore cerebral damage, when present in addition to the clot, was focal in nature. A careful review of their case his-

tories reveals that a majority of their patients arrived for treatment conscious and in good condition which is contrary to the experience of most surgeons reporting such cases in this country. For example, eighteen of the twenty-two patients which I am reporting in this series arrived at the hospital unconscious. All of the twenty patients who were operated upon in this series had become comatose before the operation was started and two of the twenty surgical patients stopped breathing before the operation was started and were operated upon under artificial respiration. In 1947 Voris<sup>7</sup> reported twenty-two consecutive operative cases; ten (45 per cent) died.

Not being satisfied with my own results I have undertaken a review of this series of twenty-two patients with extradural hematoma who have come under my care during the last ten years in the hopes that I might uncover my own errors and arrive at some conclusions regarding the steps which must be taken to give the patient who is suffering from this lesion his greatest chance for survival. All of the patients included in the series had massive hematomas which either caused death or seemed destined to produce death had they not been removed surgically. No patient was included in the series unless the presence of the hematoma was proved either by surgery or autopsy. During the ten-year period in which these cases were collected 1,763 patients suffering from head injury came under my care. Five hundred sixty were seen a month or more following injury; they sought consultation because of post-traumatic sequelae or complications. These were classified as "old" head injury cases and were eliminated in calculating the percentage of extradural hematomas occurring in a series of acute head injury cases. Thus, the twenty-two patients with extradural hematomas represented 1.83 per cent of my series of 1,203 acute head injury cases. Since it seems that a neurosurgeon's figures might be distorted by the probability that he sees an abnormally high percentage of head injury

\* From The University of Oregon Medical School, Portland, Ore.

patients requiring surgery, I reviewed the head injury series at one of the hospitals (Good Samaritan Hospital) in which I work and found that in the ten-year period under consideration 1,317 patients with acute head injuries were admitted to the hospital. This

TABLE I

SOURCE OF BLEEDING IN TWENTY-TWO PATIENTS WITH EXTRADURAL HEMATOMA

Middle meningeal or branch thereof.....	10
Transverse sinus.....	1
Emissary vessel (from bone to superior longitudinal sinus).....	2
Indeterminate.....	9
Total.....	22

figure included not only patients coming under my care but also those who came under the care of other attending physicians in that hospital. Among the 1,317 patients there were fifteen with extradural hematomas, representing 1.14 per cent of the total number of acute head injury patients. Both of these figures for the percentage of extradural hematomas are somewhat lower than that found by Munro and Maltby<sup>3</sup> who stated that extradural hematomas constituted 3 per cent of 1,200 head injury patients treated at the neurosurgical service at Boston City Hospital from 1932 to 1939. King<sup>8</sup> stated that extradural hematoma complicates craniocerebral injury in about 2 to 5 per cent of cases. The figures in my series of extradural hematoma cases may not be entirely accurate for possibly a few patients with extradural hematomas survived and left the hospital without surgery. On the other hand, I am fairly certain that no patient under my care died of extradural hematoma who did not come to autopsy. Of my twenty-two patients twenty were operated upon and six of the twenty died (30 per cent mortality). Two others were postmortem cases having never come to surgery. Thus there was a 36.4 per cent mortality for the total series of twenty-two patients.

#### SITE OF BLEEDING

Various authors have pointed out that extradural hemorrhage may originate from (1) rupture of the middle meningeal artery or one of its branches; (2) tear of one of the dural sinuses; (3) tear of an emissary vessel or (4) bleeding from the diploic vessels. The exact source of bleeding responsible for the formation of the extradural hematoma is not always easy

to find. In my own series the source of bleeding could be definitely established in thirteen cases. (Table I.) In ten of these the site of bleeding was the middle meningeal artery or one of its branches. A tear of the transverse sinus was responsible for the hematoma forma-

TABLE II

LUCID INTERVAL IN TWENTY-TWO PATIENTS WITH EXTRADURAL HEMATOMA

Lucid interval.....	18 (81.8%)
Confused or unconscious since injury.....	3
Unconscious on admission—no history available.....	1
Total.....	22

tion in one case and in two cases an emissary vein from skull to superior longitudinal sinus had been torn. In the other nine the source of bleeding was indeterminate.

#### SIGNS AND SYMPTOMS

*Lucid Interval.* Much has been written regarding the lucid interval which occurs in patients suffering from extradural hematoma. While the lucid interval is not absolutely diagnostic of extradural hematoma, it is a valuable point in favor of that diagnosis. The lucid interval may be obscured by contusion and laceration of the brain or by alcoholism. In this series of twenty-two patients eighteen were semiconscious or comatose upon arrival at the hospital. However, a history of a lucid interval was obtained in eighteen of the twenty-two (81.8 per cent), the history being obtained from a relative, friend or referring physician in most instances. (Table II.) One patient had been mentally confused during the six days between injury and his arrival at the hospital where he was operated upon while two had been completely comatose since injury. In these three cases, therefore, there was no history of a lucid interval. One patient was found alone in his wrecked car and was taken to the hospital in an unconscious condition. No history of any kind ever was available; even after the patient recovered he could supply no information regarding the accident.

*Signs of Motor and Sensory Impairment.* Since almost all patients showed impaired consciousness, signs of motor impairment were much more frequently demonstrable than sensory deficits. Thirteen of the twenty-two patients had weakness of one side of the body; in two instances the weakness was on the same



side as the hematoma while in eleven it was on the opposite side. (Table III.) Two patients had flaccidity of all extremities and two presented the picture of decerebrate rigidity. Five, so far as could be determined, displayed normal motor activity bilaterally. There were in-

TABLE III  
SIGNS OF MOTOR AND SENSORY IMPAIRMENT IN  
TWENTY-TWO PATIENTS WITH EXTRADURAL  
HEMATOMA

	Ipsi- lateral	Contra- lateral	•Bi- lateral
Motor Status			
Hemiparesis.....	2	11	
Flaccidity.....	..	..	2
Decerebrate rigidity.....	..	..	2
Tendon reflexes			
Increased.....	2	3	4
Decreased.....	..	1	5
Abdominal reflexes decreased	..	2	5
Babinski reflex			
Positive.....	3	6	10
Negative.....	..	..	3
Decreased sensation.....	..	2	

creased tendon reflexes on the ipsilateral side in two; in three the tendon reflexes were increased on the opposite side from the hematoma and there was a bilateral increase of tendon reflexes in four. One patient showed a decrease of tendon reflexes contralaterally and five had bilateral decrease of the tendon reflexes. The abdominal reflexes were contralaterally decreased in two patients and bilaterally decreased in five. In three of the twenty-two patients the Babinski sign was positive on the ipsilateral side, in six the reflex was contralaterally positive and in ten bilaterally positive. The Babinski reflex was negative in only three patients. A contralateral decrease in sensation could be demonstrated in only two patients. Sensation could not be adequately tested in the eighteen patients who were comatose on admission to the hospital. Jacksonian convulsions which are so frequently described as indicating the presence of an extradural hematoma were not observed in any of the twenty-two patients in this study.

One may conclude, therefore, that a hemiparesis is a good indication that the hematoma is on the opposite side of the brain. On the other hand, the Babinski sign is so frequently

positive bilaterally that its value as a localizing sign may be lost.

*Eye Signs.* The size of the pupils and their reaction to light change with the duration and severity of the cerebral compression. The pupil on the side of the hematoma usually

TABLE IV  
EYE SIGNS IN TWENTY-TWO PATIENTS WITH  
EXTRADURAL HEMATOMA

	Ipsi- lateral	Contra- lateral	Bi- lateral
Pupils			
Dilated and/or fixed.....	8	2	2
Contracted and fixed.....	..	..	1
Discs			
Papilledema.....	..	..	2
Blurring of disc margins...	..	..	4

dilates and becomes fixed to light; then as the cerebral compression continues the contralateral pupil also becomes dilated and fixed to light. Table IV shows the condition of the pupils at the initial examination after the patient entered the hospital. There was a dilated and/or fixed pupil on the ipsilateral side in eight patients and on the contralateral side in two. In two patients the pupils were bilaterally dilated and fixed at the initial examination but two more patients who had ipsilateral dilatation of the pupil at the first examination developed bilaterally dilated fixed pupils before surgery. One patient had contracted fixed pupils but no notation was made as to whether he might have had morphine before being sent to the hospital.

Optic disc changes were thought to be present in six patients. In two children with huge extradural hematomas there was choking of the discs and in each instance the choking was present within seven hours after injury. In four other patients there was blurring of the disc margins but no elevation of the discs.

*Vital Functions.* The classical description of the changes which occur in the vital functions when there is brain compression from an intracranial hematoma is slowing of the pulse, increase in the blood pressure, decrease of the respiratory rate and a rise in temperature. If the pressure continues, the signs change and the pulse becomes rapid and thready, the blood pressure falls, respiration becomes shal-



low, rapid and finally Cheyne-Stokes' in nature and the temperature continues to rise. However, as indicated in Table v, these vital signs will not greatly assist the surgeon in determining whether to operate upon a patient whom he suspects has an extradural

hematoma. Very few of the twenty-two patients in this series showed changes in the vital signs which were of diagnostic value.

quently the "classical" signs and symptoms of extradural hematoma are seen in young children when apparently no hematoma is present. The following case is illustrative.

On June 7, 1948, R. B., a three and one-half year old boy, fell from his tricycle and struck the

TABLE V  
VITAL SIGNS IN TWENTY-TWO PATIENTS WITH  
EXTRADURAL HEMATOMA

Pulse	
Slower than normal.....	5
Faster than normal.....	4
Blood pressure	
Higher than normal.....	7
Lower than normal.....	2
Respirations	
Rapid.....	4
Slow.....	0
Temperature	
Elevated (101.4 to 106.6°F.).....	6
Subnormal.....	1

TABLE VI  
ROENTGENOGRAPHIC AND SPINAL FLUID FINDINGS IN  
TWENTY-TWO PATIENTS WITH EXTRADURAL  
HEMATOMA

	Ipsi- lateral	Contra- lateral	Bi- lateral	
Skull fracture				
By x-ray (14 patients x-rayed).....	10	1	2	} 18
By surgery or autopsy	5	..	..	
Pineal shift.....	..	..	..	2
Spinal fluid (12 patients punctured)				
Pressure				
Above normal.....	..	..	..	8
Below normal.....	..	..	..	1
Normal.....	..	..	..	3
Appearance				
Bloody.....	..	..	..	8
Clear.....	..	..	..	2

hematoma. Very few of the twenty-two patients in this series showed changes in the vital signs which were of diagnostic value.

**Skull Fracture and Pineal Shift.** Eighteen of the twenty-two patients are known to have had skull fractures. A total of fourteen of the twenty-two patients had preoperative roentgenograms of the head while eight of the twenty-two were not x-rayed. Among the fourteen patients who were x-rayed ten had fractures on the same side as the hematoma. (Table vi.) In one patient the fracture was on the opposite side from the hematoma and in two there were bilateral fractures. In the two patients with bilateral fractures the hematomas were also bilateral. Therefore, thirteen of the fourteen patients who were x-rayed had roentgenographic evidence of skull fracture. In five of the eight patients who were not x-rayed skull fractures were found at surgery or autopsy on the same side as the hematoma. X-ray evidence of a pineal shift was found in only two of the fourteen patients.

**Cerebrospinal Fluid Findings.** Twelve of the twenty-two patients had preoperative spinal punctures and in eight the spinal fluid pressures were above normal. (Table vi.) In one the pressure was subnormal and in three the pressure was within the range of normal. The appearance of the spinal fluid was recorded in ten instances. Eight times the spinal fluid appeared bloody and twice it was clear.

**Signs and Symptoms in Young Children.** Some comment should be made upon how fre-

quently the "classical" signs and symptoms of extradural hematoma are seen in young children when apparently no hematoma is present. The following case is illustrative.

Several times episodes of a similar nature have been witnessed in young children although usually the picture is somewhat less dramatic. The attending surgeon's judgment is taxed to the utmost to determine whether surgery is indicated. He must not procrastinate too long, and if signs of improvement have not been observed within a short time exploration for extradural or subdural hematoma must be undertaken immediately.

## SURGICAL CONSIDERATIONS

Obviously the purpose of surgical treatment is to relieve the pressure on the brain as rapidly as possible by evacuating the hematoma and to employ every feasible measure to prevent a recurrence of the clot. The operation should be carried out not only in a well equipped hospital but also in a hospital where the surgeon can follow the postoperative course of the patient. Fewer patients will be lost by sending the patient to the surgeon rather than by the surgeon going to the patient. A few minutes can mean the difference between life and death, and in my opinion less time will be

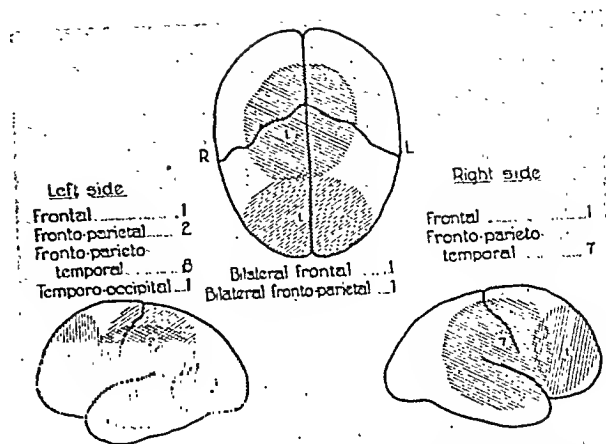
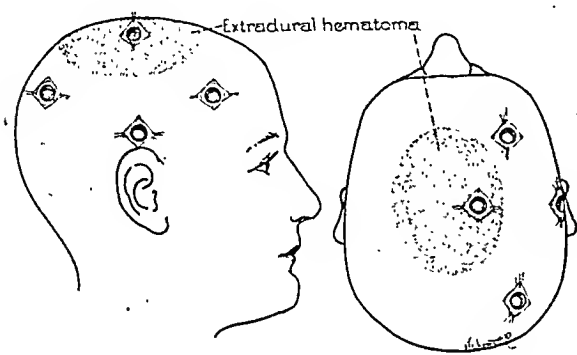
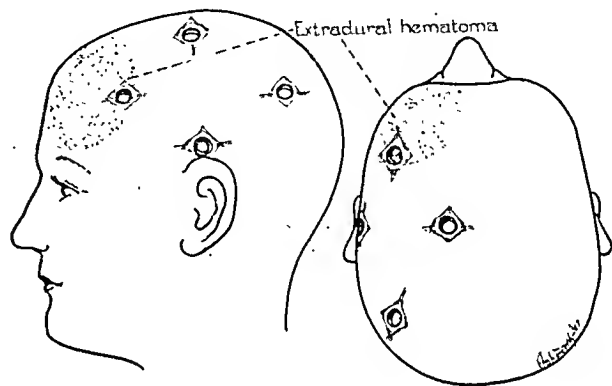


FIG. 1. Location of extradural hematomas in twenty-two patients.



2



3

FIG. 2. H. C., bilateral extradural hematoma located through a burr hole high in the right parietal area.  
FIG. 3. J. H. extradural hematoma in the left frontal region.

lost if the surgeon, upon receiving a call regarding a possible extradural hematoma case, will order the operating room in his own hospital set up rather than pack his instruments and go elsewhere to operate.

**Site of Hematoma.** In order to be evacuated the clot, of course, must first be located. A study of the location of the hematoma in this series of twenty-two cases reveals that there was one left and one right frontal hematoma. (Fig. 1.) The frontoparietal and frontoparieto-temporal hematomas on both sides totaled seventeen. There was one hematoma in the left temporooccipital region. One bilateral frontal hematoma and one bilateral fronto-parietal hematoma were encountered. I cannot agree with the opinion that one burr hole or even two will rule out an extradural hematoma. In this series one burr hole on each side in the usual location would have missed the hematoma in five instances. The following two cases are illustrative:

H. C., an eighteen year old white male, was thrown from a horse. He was instantly stunned but recovered consciousness. By the time he arrived at the hospital, one and one-half hours later, he was becoming restless and soon after admission to the hospital his left leg and left arm became weak. His sensorium became more cloudy. Neurologic consultation was requested, and the patient was operated upon approximately forty-eight hours after injury. The fourth burr hole finally located an extradural hematoma high in the right parietal area. (Fig. 2.) The hematoma was bilateral and had stripped the superior longitudinal sinus away from the bone.

J. H., an eleven year old white male, was knocked from his bicycle. He was dazed but carried on a conversation with his mother a few minutes later. When he entered the hospital, approximately thirty minutes after the accident, he was mentally clear but complained of a headache. After being in the hospital a few hours he became drowsy. Finally surgical consultation was requested, and the patient was operated upon approximately thirty-six hours after injury. A hematoma was found in

the left frontal region, the anterior burr hole being on the posterior edge of the hematoma. (Fig. 3.)

Munro and Maltby<sup>3</sup> state that of twenty patients who died following operation there were three in whom the burr holes failed to reveal the hematoma. In my own series of twenty operative cases the wrong side of the head was first burr-holed in three instances before the hematoma was finally located. I have not employed air encephalography in this group of cases because most of these patients were too ill to tolerate such a procedure. As previously stated eighteen of the twenty-two were comatose upon arrival at the hospital. Therefore, it is my conclusion that the procedure of choice is to place burr holes—as many as four if necessary—on the side of the head where one suspects the hematoma, and if the hematoma is not found burr holes should then be placed on the opposite side of the head.

*Bone Flap vs. Subtemporal Decompression.* Having located the clot and having reduced the intracranial pressure by sucking out a portion of the clot through the burr hole, the next consideration is what type of procedure will most likely effect a recovery of the patient. In eight of the twenty patients upon whom I have operated the burr hole was converted into a decompression by rongeur away bone while in twelve patients a bone flap was turned. There were four deaths among the first group of patients and two deaths among the second. I cannot definitely state that the greater number of deaths in the decompression group was the result of the procedure because it is possible that the four patients who died following the decompression type of operation would have died regardless of what procedure was employed. However, I am not in accordance with the opinion that expanding a burr hole into a decompression is the method of choice because it can be done rapidly. Once the major part of the pressure has been relieved the patient will get along just as well on the operating table while he is receiving oxygen and a blood transfusion as he will back in bed. In other words, after the pressure has been relieved there is no particular reason for rushing through the operation. Therefore, the best surgical procedure is the one which gives the best assurance against recurrence of the clot. Recurrence of the clot has, in my hands, been no small problem. To my knowledge the clot has recurred in

four of the twenty patients upon whom I operated. Fortunately, the recurrence was recognized and the four patients were re-operated upon and the clots again evacuated. All four subsequently recovered. I strongly suspect that in (R. C. J.) a recurrence of the clot was the cause of death. The patient was operated upon in a hospital 250 miles from Portland and was in good condition when I left him. The next day he became worse and expired three days after surgery. I have never operated for extradural hematoma away from home since that time.

Apparently others have been plagued with the recurrence of hematomas. Reichert and Morrissey<sup>9</sup> report two such cases. In one case the hematoma was evacuated and the wound packed. The packing was removed eighteen hours after operation, and shortly thereafter the patient became restless and stuporous. He was taken back to the operating room and a large amount of extradural blood was again found. Evacuation this time resulted in recovery. In their second case a burr hole located the clot in the left parietal area and 4 or 5 ounces of blood were removed. The burr hole was enlarged and bleeding controlled. Two days after operation the patient again became stuporous. A burr hole in the left occipital region located another large clot. A bone flap was turned in the left parietooccipital area and 4 ounces of blood were removed. The authors do not express an opinion whether this last clot was a recurrence of the original clot found in the left parietal area or whether it was present when they operated the first time but was undiscovered.

McKenzie<sup>2</sup> recognized that a clot may reform and warned, "... re-exploration is indicated if one suspects that the clot has reformed." However, a careful examination of the patients in his series revealed that he did not re-operate upon any of his patients for recurrence and that those patients who died apparently did not die from recurrence. Ellis<sup>10</sup> operated upon a patient, performing a right subtemporal decompression and removed a clot 3.7 cm. in diameter. The clot recurred and the patient was re-operated upon, with resulting recovery. Munro and Maltby<sup>3</sup> lost one patient because of failure to recognize a recurrence of the hematoma. Another of their patients had a recurrence which was recognized and operation resulted in recovery.

I have been impressed with the amount of bleeding encountered in most of these cases at the time of operation. I have wondered whether there is some undetectable cause for bleeding which is partially responsible for the formation of the original hematoma. A check of the bleeding and coagulation time in my patients has revealed no abnormalities. Nevertheless, it seems to me that the bleeding from bone and dura is more vigorous than is usually encountered in the ordinary intracranial operation. Several maneuvers have been devised to help control bleeding and therefore prevent recurrence of the hematoma. Ligation of the external carotid artery in the neck, packing of the wound with gauze and opening the dura widely have all been advocated. The results of my own experience in this series of cases indicates to me that a clot can be more thoroughly evacuated, bleeding better controlled and the danger of recurrence lessened by turning a bone flap rather than performing a subtemporal decompression. (Fig. 4.) By means of a bone flap a wide area of the dura which has been stripped away from the undersurface of the bone can be exposed. The middle meningeal artery and any major bleeding vessels can be either clipped with silver clips or ligated with silk sutures. The dura should be pulled snugly against the bone edge by means of sutures placed not more than 1 cm. apart; bits of gelfoam or fibrin foam underneath the bone edge may aid in controlling the bleeding. If the exposed dura continues to bleed, the dura may be opened and the dural flap completely excised, resuturing the dural flap as one would a free graft. If the undersurface of the bone flap continues to bleed, the bone flap may be detached completely, then tied in place, or sutures taken in the dura may be brought out through the bone and skin flap to the outside according to the method of Poppen.<sup>11</sup>

#### ANALYSIS OF DEATHS

An analysis of the cause of death in the fatal cases reveals that some patients might have recovered if their cases had been handled differently. The fatal cases have been segregated into four categories: (1) croneous diagnosis; (2) delay in operation; (3) recurrence of the hematoma and (4) concomitant severe brain injury.

*Erroneous Diagnosis.* In one instance the patient died because the diagnosis of contusion

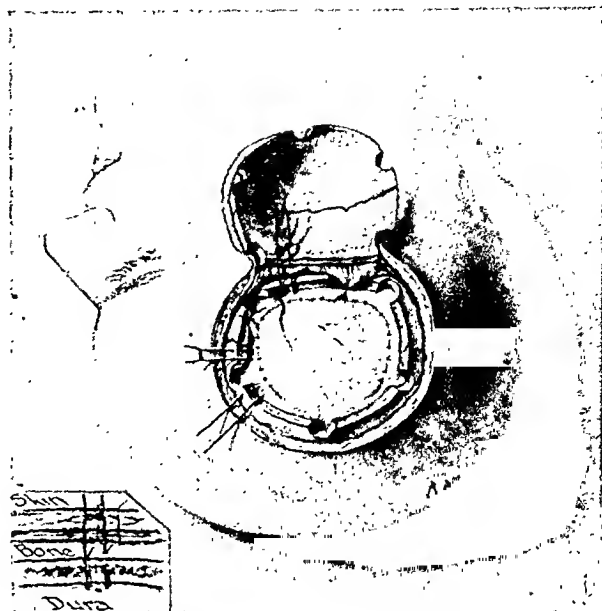


FIG. 4. Method of preventing recurrence of extradural hematoma.

of the brain rather than extradural hematoma was made. (R. R.) was brought to the hospital approximately two hours after he had sustained a head injury. A low cerebrospinal fluid pressure, very bloody spinal fluid and negative Babinskis were the principal points which led me to believe that the patient had a severely contused brain rather than an extradural hematoma. He died seven hours after being admitted to the hospital, no surgery having been performed. Autopsy revealed a huge extradural hematoma.

*Delay in Operation.* In two cases the delay of the operation was the fault of the attending physician. In another two instances it was failure of relatives to recognize the seriousness of the condition; therefore, these patients were not brought to the hospital until *in extremis*.

J. H. was struck on the head by a sapling and was taken to the hospital in a small town. Apparently the attending physician was not aware of the gravity of his condition. He gradually became worse over the next five days and was finally transferred to Portland *in extremis*. An extradural hematoma was evacuated immediately but the patient failed to improve. Re-exploration was undertaken two days after the first operation but no recurrence of the hematoma was found. The day after the second operation he expired and it was thought that severe, prolonged compression of the brain, even though the hematoma was eventually evacuated, was responsible for his death.

R. O. was admitted to the hospital about noon in relatively good condition. During the afternoon he was observed by the house staff and his condition seemed to remain fairly good. However, at 6 P.M. his respirations suddenly ceased. He was operated upon under artificial respiration. After evacuation of an extradural hematoma he resumed respirations and the intratracheal tube was removed. The patient shortly thereafter vomited a large quantity of material and aspirated the vomitus. He died twelve hours after injury or ten hours after being admitted to the hospital. Had he been operated upon during the afternoon when his condition was better he no doubt would have survived.

J. G. was brought to the hospital eight hours following injury. His condition was relatively good for seven hours after he was hurt. Respirations stopped one-half hour after arrival at the hospital. Operation was undertaken under artificial respiration but he failed to recover, his heart stopping five hours after the operation had been completed.

R. J. was in *extremis* on arrival at the hospital seven hours after injury. The parents had delayed action waiting for the family doctor. Immediate surgery was advised when the patient finally reached the hospital, but he died on the elevator on the way to the operating room.

*Recurrence of the Hematoma.* As previously stated recurrence of the hematoma may have accounted for one of the deaths. The patient was operated upon in a small town, and his condition was good at the conclusion of the operation; however, he died three days later without re-exploration. No autopsy was obtained.

*Concomitant Severe Brain Injury.* Concomitant severe brain damage was responsible for two deaths. B. O. was in very poor condition on arrival at the hospital four hours after injury. He was operated upon immediately and the hematoma evacuated but he failed to improve. He died twelve hours following operation. While autopsy showed no recurrence of the extradural hematoma, he had intracerebral hemorrhages, particularly in the pons.

The intrapontine hemorrhage may have been the result of the original injury to the head or it could have been the result of severe, prolonged compression of the brain. Intrapontine hemorrhages are not infrequently seen in patients with severe brain compression such as those suffering from intracranial tumors.

A. K. was in poor condition when he arrived at the hospital. Surgery was performed six hours after his arrival. The brain was badly lacerated

and an extradural hematoma was present. Evacuation of the hematoma failed to cause improvement in the patient's condition and he died approximately six hours after surgery.

#### CONCLUSIONS.

1. The twenty-two extradural hematoma cases herein reported constituted 1 to 2 per cent of acute head injury cases.

2. Twenty of the twenty-two patients in this series were operated upon and six of the twenty died (30.0 per cent mortality). Two additional postmortem cases are included in the series (36.4 per cent mortality for the twenty-two cases).

3. The middle meningeal artery or one of its branches was the most frequent source of bleeding but tear of a venous sinus or emissary vein accounted for a few of the hematomas in this series.

4. A history of a lucid interval was the most constant diagnostic point in cases of extradural hematoma.

5. Hemiparesis was a more constant localizing sign than changes in tendon or superficial reflexes. The Babinski reflex was more often bilaterally positive than unilaterally positive and therefore was frequently of no localizing value.

6. An ipsilateral dilated and/or fixed pupil was recorded as being present in eight (36.4 per cent) of the twenty-two patients. A dilated and/or fixed pupil occurred one-fourth as frequently on the contralateral side as on the ipsilateral side.

7. Skull fracture was recorded as being present in eighteen patients (81.8 per cent) and was usually on the ipsilateral side although in one instance it was contralateral to the hematoma.

8. The spinal fluid pressure was usually elevated but was normal or subnormal in some cases.

9. Surgical evacuation of the hematoma must be undertaken with all speed in a well equipped operating room and in a hospital where the surgeon can follow the patient post-operatively. The patient must be brought to the surgeon—not the surgeon to the patient. One must be on constant guard against a recurrence of the hematoma.

10. One burr hole on each side of the skull is not enough to rule out extradural hematoma.

11. A bone flap is usually a more satisfactory operation than evacuation of the hematoma through an enlarged burr hole.

12. In the series of twenty-two cases herein reported had all attending physicians been alert and acted promptly, four of the eight deaths might have been averted. Prompt action by relatives would conceivably have saved another two, thus reducing the deaths from eight to two which seem to have been inevitable because of concomitant brain injury.

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#### DISCUSSION

ELISHA STEPHENS GURDJIAN (Detroit, Mich.): Dr. Raaf stated that most extradural hematomas are due to a rupture of the middle meningeal vessels. It is rather important to point out that the bleeding in most of these cases is both venous and arterial, but more venous than arterial, and the middle meningeal groove actually is caused by three or four veins that accompany the middle meningeal artery along the lateral aspect of the skull.

The mechanism of extradural hematoma of middle meningeal origin, unassociated with fracture of the skull, is interesting. It can occur. Extradural hemorrhage, particularly in the frontal region, may occur unassociated with a fracture of the skull. This was experimentally shown by Sir Percival Pott more than one hundred years ago when with the use of a flat wooden mallet he was able to cause deformations of the skull unassociated with fracture, resulting in tearing off of the dural lining from the skull with beginning bleeding in the extradural region. Such bleeding can cause dissection of the dura off the skull, with more bleeding from the small veins of the dura which connect with the skull. This may eventuate in a huge clot formation, particularly in the frontal region.

The lucid interval has been less common in our series. If the patient has a severe head injury, such as in a deceleration impact in an automobile accident, the concussive effect of the blow may not permit the patient to recover from the initial unconsciousness and the patient may then lapse into the unconsciousness caused by the extradural hematoma and for all intents and purposes he may remain unconscious throughout.

In such cases, therefore, the most significant observation is increasing drowsiness or increasing unconsciousness and increasing inability to react to stimuli such as pinching, pin prick, etc.

If patients develop the hematoma from blows such as falling off a bicycle—and by the way, many instances of extradural hematoma result from bicycle-automobile accidents—then the chances for a lucid interval are good in such cases. The focal signs, as Dr. Raaf brought out, are quite positive in these cases and the most typical syndrome is a dilated pupil on the ipsilateral side, with weakness or paralysis of the opposite half of the body. This is obtained frequently when the hematoma is in the frontotemporoparietal region. With the hematoma elsewhere or high up over the interparietal area, the patient usually has equal pupils or constricted pupils and the dilated pupil on the side of the lesion described by Hutchinson is not seen.

Dr. Raaf's idea about making multiple exploratory holes is a good one since there is always a chance that one may miss these hematomas in other than the usual places and multiple trephine openings may help locate such lesions.

Spinal puncture on these patients usually reveals bloody fluid. If the spinal fluid is bloody, this does not rule out middle meningeal hemorrhage. In other words, then, just because the patient has a bloody spinal fluid to say that he is suffering from contusions and bruises of the brain would be a bad mistake in cases complicated with extradural hematoma. All of the patients that we

have punctured have had bloody spinal fluid even though the hemorrhage was mainly in the epidural space.

Finally, a word on the question of operative treatment of these patients, subtemporal decompression versus the bone flap. If the hemorrhage is in the frontotemporoparietal area, subtemporal decompression works quite well since most of the hemorrhage is under the temporal muscle. I would say we have done about 75 per cent subtemporal decompressions and 25 per cent bone flaps. If, on the other hand, the hemorrhage is in areas other than the subtemporal region, such as over the vertex and the frontal region, obviously a small bone flap would be preferable.

HARRY E. MOCK (Chicago, Ill.): Many writers in the past have stated that extradural hemorrhages seldom occur in children. The explanation given for this is the intimate attachment of the dura to the skull bones in childhood. This probably accounts for the fact that some of the worst compound fractures we have seen have occurred in children with the dura badly torn and with blood, cerebrospinal fluid and macerated brain escaping. Nevertheless, extradural hemorrhages do occur in childhood and far more frequently than we have been led to believe. Of 18 patients with extradural hemorrhages operated upon by us five were children. Four of them had small linear skull fractures and one had a simple depressed fracture. All five of these cases occurred in communities from 25 to 125 miles from Chicago. All of them were in serious condition when we were called in consultation. As soon as the diagnosis was made the operation was performed in the local hospital. In our opinion moving them back to our hospital in Chicago would have jeopardized their lives. Dr. Raaf and I differed on this point last year but I still believe the "surgeon must go to the skull fracture case, not the skull fracture to the surgeon." There are exceptions, of course, but this is a good rule in the majority of serious brain injury cases. If we break the rule, then the consultant, after seeing the patient, should be the one to break it. Four of these children recovered, the one with the depressed fracture died.

This case of a depressed fracture with an extradural hemorrhage raises another important point that needs emphasizing. Most of us have taught that the depressed skull fracture is not an emergency. It can wait several days or until the patient's condition has improved before operation need be performed. One of my father's students became an assistant to a good general man near Chicago. Shortly thereafter a six year old boy was admitted to their service in the local hospital, with a depressed skull fracture. He was unconscious but not in a grave condition. This ex-student who first saw the patient refused to have the child x-rayed

at once, which was right. The next day the child was worse and the senior doctor insisted on an x-ray which revealed a depressed fracture in the right parietal region. He thought an operation should be undertaken. The ex-student quoted my father as strongly advising delayed operation for such depressed fractures. At the end of the third day following injury my father was called in consultation. The child was in an extremely serious condition with the focal signs disguised by a deep coma. Operation was indicated but it was probably too late to be of benefit. At operation a fair sized extradural hemorrhage was found nestled beneath the simple depression.

Dogmatic teaching such as this is dangerous and undoubtedly cost this child his life. Great emphasis should be placed upon the possibility of an extradural hemorrhage lying beneath every depressed skull fracture. At the first evidence of focal signs immediate rather than delayed operation is necessary.

During the last year Dad, Charles J. Mock and I have become interested in intracranial injuries in football players. We found that the American Football Coaches' Association had records of deaths among sand lot, high school and college football players since 1931. During the sixteen years until 1947 there were 307 deaths directly due to football and 46.3 per cent of these were due to brain injuries—usually signed out as "cerebral hemorrhages." During the 1947 season twenty-four football players were killed and twelve of these (50 per cent) died from intracranial injuries.

We have contacted the authorities in these schools and through them have corresponded with the doctor, hospital or coroner responsible for each of these twelve patients. Two of them had extradural hemorrhages and one a subdural which were found at operation before death. The remaining nine cases were all signed out as "cerebral hemorrhage" deaths. Only two of these twelve had autopsies. Coroners are very loath to perform autopsies especially in our smaller communities and especially on a boy who, through the nature of his death, has become a local hero. How many of the 150 "cerebral hemorrhage deaths" in football players since 1931 were really extradural hemorrhages?

Laws should be enforced requiring an autopsy on every skull fracture-brain injury death. Only in this way will we learn how many of these extradural and subdural hemorrhages are being overlooked and the patients allowed to die without benefit of surgery. Skull fractures and cerebral hemorrhages should be considered general terms not acceptable as the cause of death without a careful description of the specific intracranial lesion or lesions.

JOHN E. RAAF (closing): I certainly agree that extradural hemorrhage does occur in childhood. I do not have in mind just how many of our twenty-two patients were children, but I can recall at least five in our series.

Dr. Moek, Sr. and I have been arguing for several years regarding the question of whether the surgeon should go to the patient or the patient to the surgeon. Apparently at the present time there is still no meeting of the minds but we have lots of fun arguing.

I agree that depressed skull fracture is not a surgical emergency unless it is a compound depressed skull fracture. In my experience most of the extradural hematomas have occurred underneath linear fractures rather than underneath depressed skull fractures, and an extradural hematoma, in my opinion, is certainly a grave surgical emergency. I have seen patients with extradural hematomas die within five or six hours of the time of injury.





# RESTORATION AND PRESERVATION OF ARTERIAL CONTINUITY FOLLOWING TRAUMA

LESTER BREIDENBACH, M.D. AND JERE W. LORD, JR., M.D.

*New York, New York*

**D**URING the past five years interest among surgeons has been focused on methods to maintain arterial continuity in the treatment of injuries to an artery of an acute and chronic nature. Matas,<sup>1</sup> Blakemore,<sup>2</sup> Freeman,<sup>3</sup> Shumacker,<sup>4</sup> Herrmann<sup>5</sup> and Wisc<sup>6</sup> have emphasized the importance of preservation of the main arterial flow as the ideal in the management of acute arterial injuries as well as traumatic arterial aneurysms and arteriovenous fistulas.

Reid,<sup>7</sup> Holman<sup>8</sup> and Elkin<sup>9</sup> by their excellent experimental and clinical studies have shown that quadruple ligation and excision of a traumatic arteriovenous fistula is followed by improvement in the circulatory dynamics and cure of the fistula. However, relative vascular insufficiency of an extremity which limits full exercise tolerance following interruption of arterial continuity has been clearly demonstrated by Blakemore.<sup>2</sup> For that reason the ideal cure of the fistula and maintenance of continuity of the artery have been sought by a number of surgeons and achieved with considerable success.<sup>2,3,4</sup>

During World War II many efforts were made to restore continuity of an artery following an acute injury and certain obstacles were encountered which made this aim difficult to achieve regardless of the technical method employed.<sup>10,11</sup> The time factor between the occurrence of injury and adequate operative facilities was frequently twelve to seventy-two hours and this alone was responsible for failure of many arterial anastomoses to function. Secondly, a large percentage of the casualties sustained multiple severe injuries associated with shock which precluded the time-consuming operation of arterial anastomosis. However, in civilian practice acute trauma to an artery may occur during the course of an operation such as periarterial sympathectomy, hernioplasty, varicose veins, etc. Further, patients having arterial trauma resulting from stab and gunshot wounds and compound

fractures are usually admitted to the hospital within one to four hours after injury and can be cared for promptly and effectively. With proper vascular equipment and personnel trained in arterial anastomosis many of these arteries can have their continuity restored with resulting salvage of a greater number of useful extremities.

## ACUTE ARTERIAL INJURIES

In the management of acute arterial injuries certain points must be considered which are essential for the success of an anastomosis: First, attention to details which will lessen the possibility of infection: (1) adequate and thorough débridement in a contaminated wound; (2) skin exclusion by towels and Michel clips; (3) administration of large doses of penicillin. The second important factor has to do with the technic of anastomosis. If there has been loss of arterial substance, a vein graft should be employed rather than the suturing of the ends of the artery under longitudinal tension. Further, if a vein graft is joined by means of the non-suture Vitallium tube technic, certain details of the method should be observed. (Fig. 1.) On the other hand, if the vein graft is sutured to the ends of the artery, careful technic is imperative not to injure the intima of the artery or vein. Either the Carrel method or the continuous mattress suture technic may be employed for secure anastomosis.<sup>12</sup> The third important factor is the use of anticoagulant therapy postoperatively to aid in the prevention of thrombosis. Heparin is injected intravenously immediately at the completion of the anastomosis and continued postoperatively either by the intermittent intravenous or subcutaneous route until dicumarol effect is evident by determination of the prothrombin time. Anticoagulant therapy should be maintained for seventeen to twenty-one days. The fourth important factor is the elimination of arterial spasm by means of the judicious use of any one or combinations of

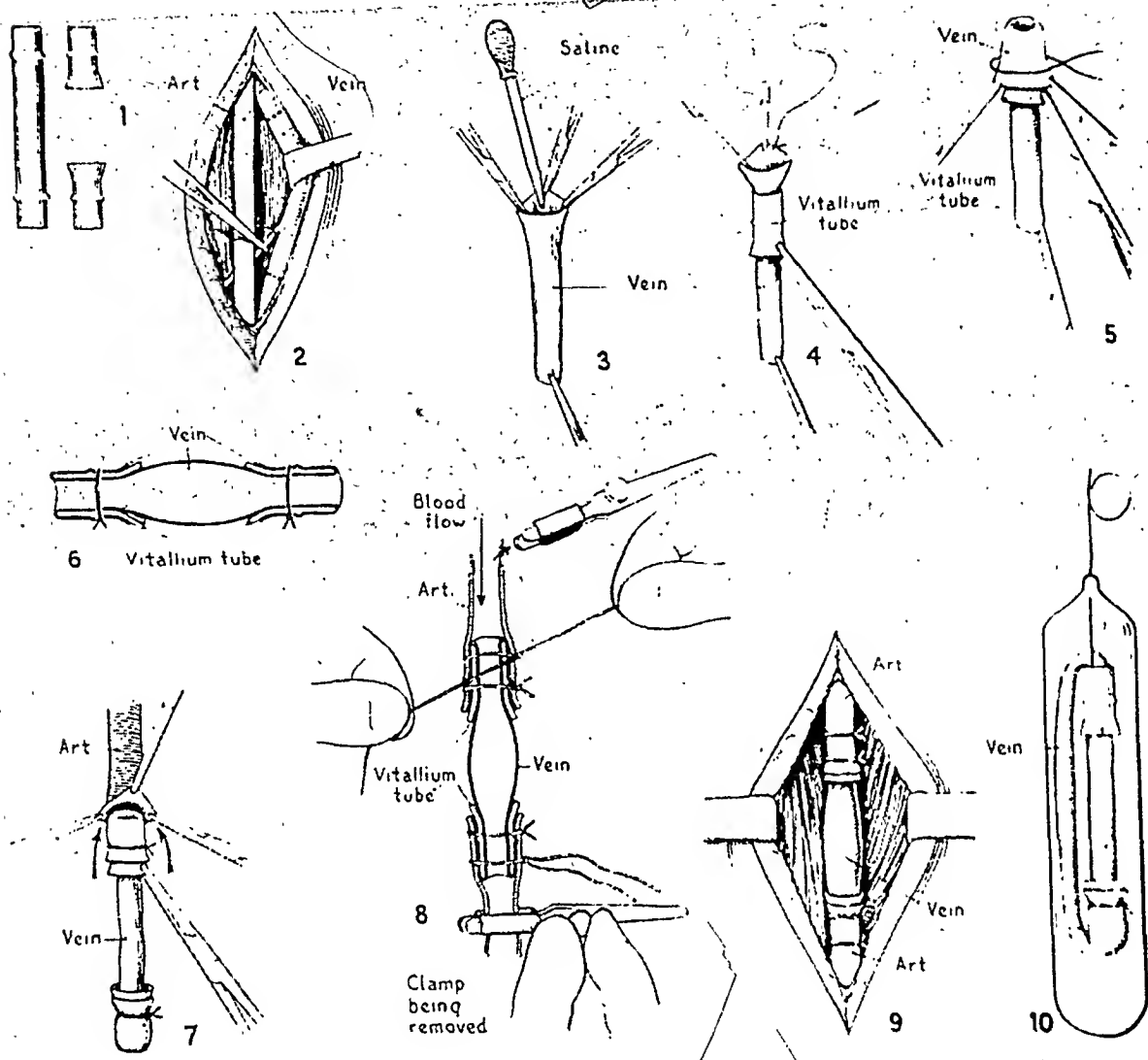


FIG. 1. Operative technic of the non-suture method. 1. Cannula and tubes (for use in the single or double tube technics). 2. Removal of vein graft; note that the branch is tied close to the vein with fine silk before clamping. 3. Irrigation of vein graft with isotonic solution of sodium chloride to which a small amount of heparin may be added if desired. 4. Method of triangulating end of vein with mosquito clamps. 5. Cuffing and securing everted end of vein on the Vitallium tube. 6. Double tube technic with the vein graft mounted. 7. Introducing the distal end of the vein graft mounted on a Vitallium tube into the proximal end of the artery. 8. Tying fine silk ligatures just snug enough to prevent blood from penetrating between the vein and artery intimas. Also releasing the proximal rubber shod clamp first to facilitate the passage distalward of any residual air bubbles within the graft. 9. Completed anastomosis; the perivascular tissues are closed snugly around the anastomosed artery when possible. 10. A convenient way of preserving, hermetically sealed in an ordinary test tube, a vein graft for quick freezing. The graft is moistened with isotonic solution of sodium chloride, one end mounted on a Vitallium tube in the usual manner and the other end is passed through a second tube and brought over the first tube to protect the intima until used. A wire serves to suspend the graft.

the following: papaverine, tetraethylammonium chloride, paravertebral procain block and sympathectomy.

To illustrate the principles discussed above we would like to cite two cases of acute arterial trauma in which arterial anastomosis was attempted but resulted in failure:

A twenty-eight year old man sustained a posterior dislocation of the knee joint in an automobile

accident and was admitted to City Hospital where it was evident that the popliteal artery had been severed. He was operated upon within five hours of his injury, the dislocation reduced and the popliteal artery which had been completely divided was sutured under great longitudinal tension. Twenty-four hours later evidence of gangrene developed because of inadequacy of the anastomosis and amputation was performed.

The second case was a fifty-eight year old white man who sustained an injury in the course of an operation on his saphenous vein. The artery was clamped but prior to division was identified. On removal of the clamp bleeding ensued necessitating re-clamping. Following removal of the crushed part of the artery, end-to-end anastomosis was effected under considerable longitudinal tension. Pulsations of the popliteal and dorsalis pedal arteries were easily palpated and oseilometric readings were equal in both legs. The patient was treated with penicillin and papaverine and had an uneventful postoperative course until the thirteenth day when sudden hemorrhage occurred requiring exploration of the wound and ligation of the separated ends of the artery. Wound infection was evident only in the deeper parts by the collection of pus around the artery. Failure to prevent infection and longitudinal tension in the anastomosis were the two factors which led to this unsuccessful attempt to maintain continuity. Although gangrene did not occur subsequently, the patient has had marked evidence of arterial insufficiency.

The following two patients operated upon by Blakemore<sup>2</sup> illustrate a satisfactory method of management of acute arterial injuries resulting from falls through a plate glass door or window:

M. E., a seven year old boy, was admitted to the Presbyterian Hospital July 20, 1943, in shock due to hemorrhage from a severed brachial artery. The boy's left arm had been pushed through a glass door while at play. He received an irregular laceration across the inner aspect of the middle section of the arm. The brachial artery, median and ulnar nerves were severed. The patient was promptly given 500 cc. of blood, 300 cc. of isotonic solution of sodium chloride and 2 Gm. of sodium sulfadiazine intravenously.

Five hours after injury a pneumatic tourniquet was applied well above the wound under ether anesthesia. The skin was carefully prepared and the wound thoroughly irrigated with saline. The retracted ends of the severed brachial artery were freed for a distance of 5 to 6 cm. The tourniquet was released sufficiently to flush out severed vessels. Rubber shod clamps were applied to the ends of the severed artery and the latter irrigated with saline. The cut ends of the brachial vein were transfixed with C Deknatel silk. As débridement proceeded, the smaller vessels were ligated with B Deknatel silk. At this point of the operation the team divided. This enabled one section to proceed with repair of the nerves, using arterial silk, while the other proceeded with preparation of a vein graft for bridging the arterial defect. Accordingly, the left superficial femoral vein was isolated for a

distance of 10 cm. distal to the origin of the profunda. Branches were ligated with B. Deknatel silk flush with the vein, clamped, cut and ligated distally. A ligature of No. 1 Deknatel silk was placed on the distal end of the femoral vein. The blood was milked upward and another ligature placed proximalward. The vein was further secured with transfixion ligatures and the intervening segment removed. The vein graft was thoroughly irrigated with saline. A silk suture on a straight needle passed through the wall of the distal end served to pull the vein through a 2 mm. Vitallium tube and later, when cut short, to identify the distal end of the vein graft. The end of the vein was everted (cuffed) over the Vitallium tube and held in place by a ligature of No. 1 Deknatel silk placed behind a tying (holding) ridge. The other end of the vein graft was mounted in identical manner on a second 2 mm. Vitallium tube. (Care must be taken to avoid a valve at the eversion site to prevent diaphragm occlusion.)

Next, the severed ends of the artery were débrided and again irrigated to remove clinging particles of fibrin. (Control of blood flow by the rubber shod clamps placed well away from the ends must be absolute.)

The distal end of the severed artery was then triangulated by placing mosquito clamps, taking 1.5 mm. bites on the cut edge. The flange of the Vitallium tube carrying the proximal end of the vein graft was grasped with a stout, straight clamp and the graft was dipped in saline. Following this, the vein covered tube was introduced into the funneled end of the artery and the latter brought well up on the tube. The artery was secured to the tube, intima to intima with the vein, by a No. 3 Deknatel ligature tied tightly behind the holding ridge, using a surgeon's knot. The second Vitallium tube bearing the distal end of the vein graft was irrigated with saline (using a blunt-nosed medicine dropper) and introduced into the proximal end of the artery in an identical manner. Finally, ligatures of No. 1 Deknatel silk were placed around the artery, barely snugging the artery to the cuffed vein at a point 1 to 1.5 mm. from the ends of the Vitallium tubes.

Just before removing the rubber shod clamps, 15 mg. of heparin (1.5 cc. of Liqueamin) were injected into the artery proximal to the anastomosis, using a hypodermic needle. The proximal clamp was removed first, followed immediately by removal of the distal rubber shod clamp.

A pink color of the boy's hand resulted immediately after re-establishment of blood flow and only a few minutes elapsed before the left hand was as warm as the right. The muscles, fascia and skin were approximated with fine silk. The patient received 300 cc. of blood during the operation and left the table in excellent condition. The arm

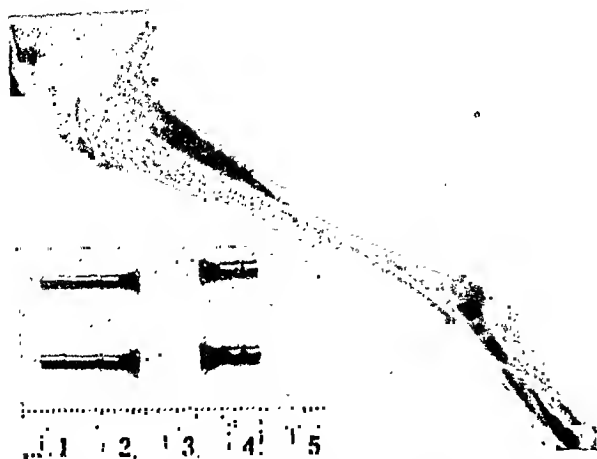


FIG. 2. Arteriogram of the anastomosed brachial artery in the first case one month after operation. Whereas the funneled ends of the Vitallium tubes are close together, a column of diodrast may be noted passing through the intervening vein graft. Compare the long tubes as used in this case with the shorter tubes of recent design shown in the inset.

was placed in a plaster splint with the hand in volar flexion.

Postoperatively the wound healed per primam. The patient was discharged on the eleventh postoperative day in a constant tension splint to permit exercise of unopposed extensor muscles but to protect the paralyzed flexor muscles of the forearm against overstretching. Sulfadiazine therapy was continued through the fifth postoperative day. Daily observation of the left radial pulse revealed it unchanged in volume.

Follow-up one month later showed that the patient was receiving physiotherapy. The left radial pulse remained good. An arteriogram (Fig. 2) confirmed the patency of the anastomosis. However, thrombosis of the anastomosis took place immediately following the injection of diodrast. Five months later chronaxia studies revealed innervation of the forearm muscles supplied by the median nerve. At examination fourteen months later there was complete sensory and motor recovery of the median and ulnar nerves. However, there was some inability to extend the fingers completely due to weakness of the interosseus muscles, although chronaxia studies revealed complete regeneration. Seventeen months later there was complete return of function.

R. J., a fifteen year old colored boy, entered the Presbyterian Hospital July 7, 1944, with a severe laceration of his left arm. He incurred the injury falling through a plate glass cellar window. A tourniquet was promptly applied. After his arrival at the hospital some hours later a pneumatic tourniquet was applied and deflated at one-half hour intervals. Family and past history was non-contributory.

November, 1948



FIG. 3. Lateral (A) and anterior (B) views of the wound in the second case.

Physical examination revealed the temperature to be  $101^{\circ}\text{F.}$ , pulse 132, blood pressure 160/80. He was an apprehensive, well developed boy, not in shock. Examination of the left arm revealed a transverse laceration starting in the mid-biceps region, directed obliquely downward, dividing all soft parts to the bone and entering the elbow joints anteriorly. The laceration involved approximately two-thirds of the circumference of the arm. The radial and median nerves were severed as were the brachial artery and accompanying veins. As a result of muscle retraction the wound gaped widely. The forearm and hand remained cold, pale and pulseless following release of the tourniquet. (Fig. 3A and B.)

The operation consisted of irrigation and débridement of the wound, with suture of the radial and median nerves. The brachial artery defect was bridged with a segment of saphenous vein using the non-suture technic with a 4 mm. Vitallium tube on each end. Twenty mg. of heparin (2 cc. of liquaemin) were given intra-arterially on establishing blood flow through the anastomosis; 5 mg. of sodium sulfadiazine were given in saline during the operation. Hemostasis was completed and the muscles, fascia and skin were sutured. Silk technic was used throughout. The arm was placed in a posterior molded plaster splint with the elbow at right angles. An excellent radial pulse was felt on releasing the brachial artery to blood flow. The wound healed per primam. The radial pulse remained excellent and thirty-four days postoperatively an arteriogram confirmed the patency of the anastomosis. (Fig. 4.)

Follow-up examination at four months showed the radial pulse to be excellent. Chronaxia studies revealed the innervation of the forearm muscles. Muscles supplied by the tourniquet damaged ulnar nerve responded to direct stimulation, whereas there was no response from those supplied



Fig. 4. Arteriogram in the second case thirty-four days after operation. The patent saphenous vein graft is about the same size as the anastomosed brachial artery. The slight bulge of the upper end of the graft marks a valve site in the vein graft.

by the sutured radial and median nerves. Furthermore, the latter muscles were more wasted and fibrotic. Seven months later there was beginning nerve regeneration below the elbow; the radial pulses remained equal.

Holzer<sup>13</sup> recently reported two remarkable cases of acute traumatic lacerations of the abdominal aorta in which continuity was maintained by suture in one and an unlined Vitallium tube in the other.

There are other types of acute traumatic arterial emergencies than the severed artery. For example, contusion of an artery may be followed by thrombosis with its potentially disastrous effect. Proper treatment, however, may be effective in preventing such an unfortunate outcome. The following case is illustrative:

A seventy year old woman fell and sustained a subglenoid dislocation of her left humerus. Exami-

nation revealed absence of pulsation of the brachial and radial arteries and no blood pressure or oscillometric readings were obtainable in the involved arm. Under pentothal anesthesia the dislocation was successfully reduced. However, pulse, blood pressure and oscillometric readings remained absent for two hours when following an intravenous injection of procaine the blood pressure was recorded at 120/100 in contrast to 190/110 in the right arm. An oscillometric reading of 1.0 was noted in the left forearm whereas 2.5 was obtained in the right forearm. The patient was started on heparin, 30 mg. every three hours subcutaneously, and 300 mg. of dicumarol were administered by mouth. Forty-eight hours after injury a feeble brachial pulse could be palpated but the radial pulse remained absent for seven days, then gradually returned to normal by the fourteenth day. The blood pressure levels had equalized in the two arms on that day. The exact extent of the injury to the axillary artery in this case cannot be ascertained but it would seem that spasm was present early and persisted because of contusion of the wall of the artery. Although the final outcome may have been as satisfactory without specific treatment, we believe that the use of anticoagulant therapy for several days was useful in guarding against secondary thrombosis. Measures designed to counteract spasm were employed in the form of intravenous procaine and papaverine.

An example of impairment of arterial circulation by pressure and its adequate treatment is shown by the following case:

A nine year old boy fell while playing in the street and sustained a supracondylar fracture of the right humerus. Closed reduction was attempted under anesthesia but was unsuccessful. The manipulation resulted in a progressively enlarging hematoma which caused a gradual obliteration of the radial pulse. Twenty-four hours later the subfascial hematoma was evacuated by incision with immediate return of the radial pulse. Uneventful convalescence followed reduction of the fracture.

In a few carefully selected patients secondary restoration of the continuity of an artery at some period after the primary injury may be worth while. When a major artery has been ligated and the extremity has survived, circumstances may subsequently develop which would necessitate secondary re-establishment of arterial continuity if gangrene is to be averted. It is to be clearly understood that all conservative measures to promote the development of collateral circulation have been employed including sympathectomy. In spite

of the best efforts to augment the collateral circulation some of these extremities go on to impending and occasionally frank gangrene. It would be in this small group that exploration of the region of the divided artery for the purpose of re-establishment of blood flow by means of a vein graft may be efficacious. The following case is illustrative:

A fifty-eight year old white man sustained an injury to his right common femoral artery in the course of an inguinal hernioplasty. The artery was ligated and during the immediate postoperative period the extremity remained viable. In spite of the usual measures to promote collateral circulation, including paravertebral procaine blocks, beginning gangrene of the second toe developed by the seventh postoperative week. Exploration of the common femoral artery revealed fibrosis in juxtaposition to the points of ligation over a distance of 3 cm., with patency of the artery proximally and distally. Technical difficulties due to inadequate armamentarium resulted in a poor anastomosis of the vein graft to the ends of the artery which led to thrombosis on the first postoperative day in spite of anticoagulant therapy. It is our belief that the findings at operation in this case were entirely compatible with a successful restoration of arterial continuity.

Blakemore,<sup>2</sup> Freeman<sup>3</sup> and Shumacker<sup>4</sup> have emphasized the importance of maintaining arterial continuity in the management of arteriovenous fistulas. The following two cases illustrate its application:

A sixty-three year old colored male was admitted to Bellevue Hospital in cardiac decompensation. An arteriovenous fistula was discovered between the femoral artery and vein. It had apparently resulted from an incision and drainage of a suppurative inguinal adenitis thirty years previously. Following measures to improve cardiac function the fistula was excised, the femoral vein ligated above and below the fistula and arterial continuity restored by means of a vein graft taken from the superficial femoral vein and joined to the ends of the artery by the Carrel suture technic. Postoperative convalescence was uneventful and pulsations and oscillometric data in the extremity were entirely normal (preoperative 1.5, postoperative—one week—3.0). The patient has full functional tolerance of the left leg.

A forty-four year old white, construction worker developed a fistula between the right common femoral artery and vein as a result of a dynamic explosion thirteen years before admission to the Horton Hospital, Middletown, N.Y. At operation the fistula was isolated and the artery clamped

with rubber-shod clamps above and below. The fistula was then ligated and transfixed maintaining continuity of the common femoral vein. The arterial end of the fistula was divided flush with the artery and the defect closed with a continuous everting mattress suture of No. 00000 silk. A

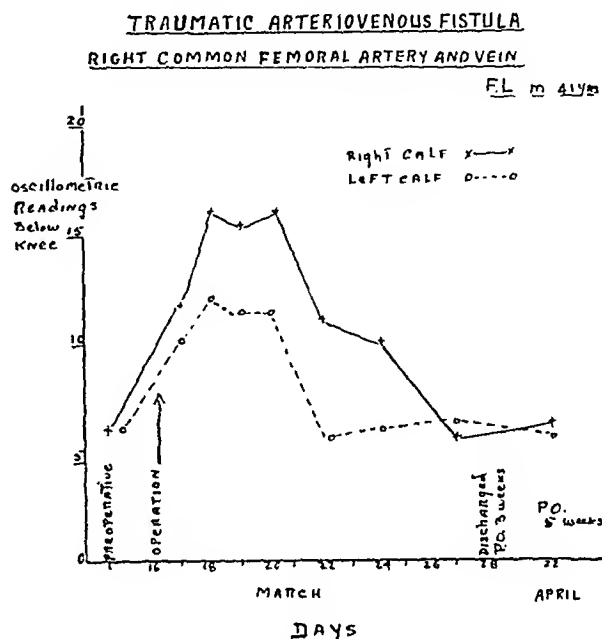


FIG. 5. Graph showing the oscillometric findings in patient F. L., traumatic arteriovenous fistula. It is of interest to note that the right calf (operated side) shows a greatly increased oscillometric swing during the early postoperative period.

3 mm. branch of the artery was also divided at the same time and it was similarly sutured. Following release of the rubber-shod clamps, arterial flow was satisfactory. The wound was closed in layers. One hour postoperatively evidence of serious arterial hemorrhage was noted. The wound was explored and the site of the small branch of the common femoral artery was found to be open. It was again closed with two interrupted mattress sutures of arterial silk. Convalescence thereafter was entirely uneventful and Figure 5 shows the oscillometric readings pre- and postoperatively. The patient has normal exercise tolerance in the right leg.

Matas<sup>1</sup> has repeatedly pointed out the desirability, when possible, of carrying out restorative endo-aneurysmorrhaphy, and more recently Blakemore<sup>14,15</sup> has reported on the vein graft Vitallium tube inlay method of treating peripheral arterial aneurysm. The technic is illustrated in Figure 6.

The first patient operated upon by this technic was a forty-two year old negro barber who was known to have had a positive Wassermann reaction

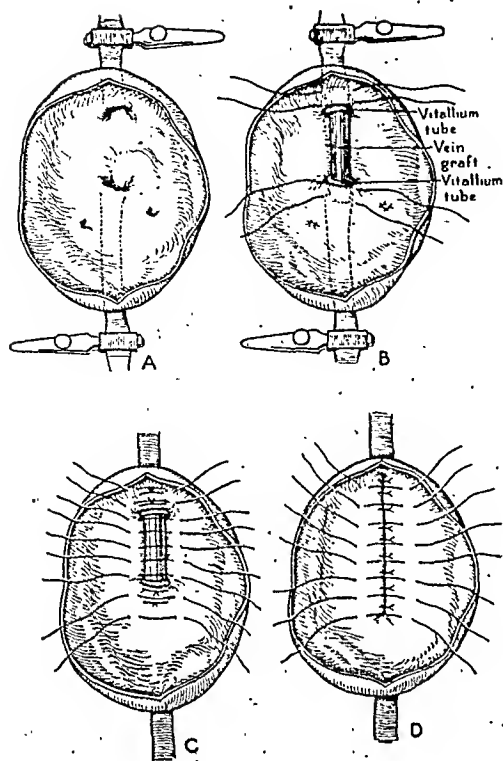


FIG. 6. The technic of intrasacular repair of an aneurysm with vein graft inlay for the maintenance of arterial blood flow.

for seventeen years before admission to the Presbyterian Hospital on May 29, 1947. Anti-luetic therapy had been carried out most of the time until three years before the present illness. The patient's Wassermann reaction became negative in 1937 and had remained so. The present illness started two and one-half years before with swelling of the right thigh. Two and one-half years before this the patient was shot through the thigh, the bullet passing through this same area, and the patient thinks some swelling persisted following the bullet injury. During the year before admission growth of the aneurysm had been quite rapid.

Physical examination revealed a well developed and well nourished man who looked older than his stated age. The pupils were regular and active to light and accommodation. The heart was not enlarged; sounds were normal; blood pressure, right arm 145/105. Lungs were clear to percussion and auscultation. The abdomen was normal except for the presence of a right inguinal hernia. A pulsating mass the size of a large grapefruit presented in the right thigh in the lower Hunter's canal region. The right dorsalis pedis pulse was barely palpable.

A diagnosis of arterial aneurysm of the femoral artery was made.

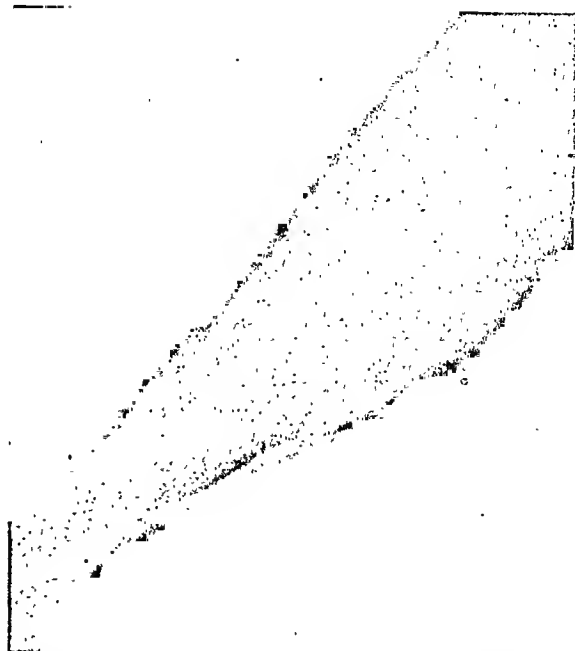


FIG. 7. Arteriogram made eleven days after the procedure shown in Figure 6. Note patency of vein graft inlay although the latter is slightly redundant.

On May 31, 1945, endo-aneurysmorrhaphy with vein graft inlay was performed. Figures 6A to D are drawings of the aneurysm revealing the technical stages. The vein graft was taken from the left superficial femoral vein and mounted on two 5 mm. Vitallium tubes in the usual manner.

Convalescence was uneventful with healing of the wound per primam. The pulse in the vessels of the right foot remained better than before operation but not quite as good as those in the left foot. (Fig. 7.)

Follow-up two months later revealed that the patient had been working continuously on his feet as a barber without swelling of the leg. The site of the aneurysm was scarcely noticeable. Pulsation in the artery distal to the aneurysm remained unchanged.

The above methods of Matas and Blakemore may also find application in arteriosclerotic, mycotic and traumatic aneurysms.

*Comment.* There are two points which should be emphasized in the management of arterial injuries. First, it is of the greatest importance to have adequate equipment for vascular surgery. This includes: (1) two small Blakemore-Crump clamps; (2) two rubber-shod Bainbridge clamps; (3) two rubber-shod bull dog clamps; (4) one large Blalock clamp; (5) one set Vitallium tubes 3 mm. to 10 mm.; (6) Deknatel No. 00000 braided silk with

atraumatic needle; (7) vaseline or mineral oil and (8) plastic needle holder.

The second important point is to avoid the sacrifice of any arterial collateral vessel. A double turn of a heavy silk suture will usually suffice to control bleeding without injury to the branch or permanent occlusion.

#### CONCLUSIONS

1. Restoration of arterial continuity in the management of acute and chronic arterial injuries and lesions is a highly desirable objective for the preservation of extremities and full functional activity.

2. Arterial continuity should be restored when possible in the following: (1) acute arterial injuries; (2) repair of arteriovenous fistulas; (3) in the management of aneurysms whether on an arteriosclerotic, luetic, mycotic or traumatic basis and (4) in selected cases of arterial injuries in which ligation was practiced as the initial treatment.

3. We are in agreement with Shumacker<sup>4</sup> that the greater the surgeon's interest in restoration of arterial continuity, the more often will successful arterial anastomoses result.

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# MANAGEMENT OF VENOUS THROMBOSIS AND PULMONARY EMBOLISM FOLLOWING INJURY TO EXTREMITIES\*

FRED B. AURIN, M.D. AND LOUIS G. HERRMANN, M.D.  
Cincinnati, Ohio

THE clinical problems which confront the surgeon in the management of patients with peripheral venous thrombosis or its dreaded consequence, pulmonary embolism, are still numerous and controversial. Some patients recover rather rapidly after fracture of long bones while others develop painful, swollen legs which require months for the return to normal function. Fatal pulmonary embolism often develops after fracture of the neck of the humerus or intra-articular fractures of the knee.

The general incidence of venous thrombosis in patients who have sustained injury to the legs is almost 12 per cent while venous thrombosis in the general surgical patients occurs in this part of the country in approximately 2 per cent of hospitalized patients.

In evaluating the definitive treatment of venous thrombosis we must constantly give proper consideration to the alterations in the clotting mechanism of the blood, to the age of the intravascular blood clots and finally to the stasis of blood which may follow the interruption of large veins.

The immediate dangers of pulmonary embolism following peripheral venous thrombosis have aroused so much interest among surgeons that there has been a tendency to minimize the serious late effects, such as residual edema, persistent pain or chronic induration of the lower legs with or without ulceration of the skin. It is our firm conviction that prevention of the complications which result from peripheral venous thrombosis is the real solution to the problem, but such a solution can only come as a result of a more universal understanding of the contributing causes, the anatomic sites where most of the intravascular blood clots form and the pathologic physiology of venous thrombosis.

Gunnar Bauer<sup>1</sup> of the Mariestad Hospital in Sweden found that the incidence of venous

thrombosis among his general surgical patients was 1.6 per cent and of this group with active venous thrombosis one of every six had fatal pulmonary embolism. During a three-year period he studied 274 patients who had had trauma to one or more extremities and found that thirty-three (or 11.9 per cent) of them had developed peripheral venous thrombosis.

His analysis of these thirty-three cases of venous thrombosis is as follows:

	Cases	Venous Thrombosis	Incidence (Per Cent)
Fracture, neck of femur.....	47	7	15
Fracture, shaft of femur.....	25	1	4
Fracture, knee joint.....	19	4	13
Fracture, lower leg.....	52	5	10
Fracture, malleolus.....	25	3	7
Traumatism, knee.....	43	3	12
Traumatism, thigh.....	30	4	21
Traumatism, lower leg.....	33	6	18
	274		

From the Medical Examiner's Office of New York City Vance<sup>2</sup> reported sixty cases of pulmonary embolism following trauma. His analysis of these cases, all of which were fatal, is as follows:

Fatal Pulmonary Embolism Following Trauma

		Per Cent
Fracture, femur.....	14	23
Fracture, tibia and fibula.....	11	18
Fracture, tibia.....	2	3
Fracture, fibula.....	7	12
Fracture, pelvis.....	5	8
Traumatism, lower extremity.....	11	18
Traumatism, trunk and head.....	10	17
Total.....	60	99

\* From the Department of Surgery of the College of Medicine, University of Cincinnati and the Cincinnati General Hospital, Cincinnati, Ohio. This work was made possible by a grant from the Lucie Rawson Scientific Fund.

Vance<sup>2</sup> found that the site of origin of the blood clot in the majority of his cases was in the large veins of the traumatized extremity. Among the cases of fractured pelvis the site of venous thrombosis was in the pelvic veins.

Martland<sup>3</sup> reported a series of eighty-six cases of peripheral venous thrombosis with fatal pulmonary embolism in which fifty-five were associated with trauma to the lower extremities.

		Per Cent
Simple fracture.....	37	67.2
Compound fractures.....	7	12.7
Contusions, bruises.....	9	16.3
Sprained ankle.....	1	01.8
Stab wound of thigh.....	1	01.8
Total.....	55	99.8

The remaining thirty-one cases followed surgical operations. In this group there were two incidents of fatal embolism occurring after the remanipulation of the fractures of the neck and shaft of the femur, two weeks and ten days following injury.

At the Cincinnati General Hospital, during a period of three months at which time one of the authors (F. B. A.) was the resident on the Fracture Service, ninety-two cases of fractures of the pelvis or lower extremity were admitted to the hospital; among this group there were twelve cases of venous thrombosis with or without pulmonary embolism. An analysis of these cases is as follows:

Analysis of Twelve Cases of Traumatic Venous Thrombosis

	Venous Thrombosis	Venous Thrombosis with Pulmonary Infarction	Pulmonary Embolism
Fracture, femur.....			
neck.....	2	..	1
intertrochanteric .....	2		
shaft.....	1	1	
supracondylar.....	..	1	
Fracture, tibia and fibula..	2		
Fracture, tibia, fibula and pelvis.....	1		
Fracture, pelvis and spine..	..	1	
	8	3	1

#### CLINICAL SIGNS OF VENOUS THROMBOSIS

Not infrequently venous thrombosis in the extremities is overlooked by hurried rounds and inattention to minor complaints of the patient. We believe that regular and frequent examination of the thighs, calf muscles and feet of all patients is essential to the diagnosis of the initial phases of venous thrombosis. This point has been emphasized by Allen<sup>4</sup> at the Massachusetts General Hospital who stated "It is not at all uncommon now to have these signs picked up before the patient is aware of any disturbance or before the chart indicates that there is this complication impending." We agree with his recommendations that we should pay particular attention to whether the veins are filled or empty, the presence or absence of tenderness in the calf muscles and presence of pain on forceful dorsiflexion of the foot (Homan's Sign).<sup>10</sup> We believe that it is important that during palpation of the deep veins of the leg the leg should be slightly flexed at the knee and at the hip in order to relax completely the muscles of the leg.

Measurement of the circumference of the extremity at various levels is not of great clinical importance because of the great variation which occurs when such measurements are made at different times of the day. We believe that greater emphasis should be placed on the degree of tenderness in the muscles of the calf, pain on dorsiflexion of the foot and tenderness along the course of the popliteal or femoral veins. These clinical findings are all the direct result of the pathologic changes which Hunter and associates<sup>5</sup> reported in the smaller veins of the muscles of the calves in these patients.

In order to make an adequate examination of the patient's lower leg we do not hesitate to bivalve the cast and completely remove the upper half. Some of our patients were in a modified type of Russell's skeletal traction or the fractured hip was pinned with a Smith-Petersen nail or Austin-Moore pins. In one of our patients who had sustained a fracture of the tibia it was not until the leg had been carefully examined several times following bivalving of the cast that we were able to make a definite diagnosis of venous thrombosis.

#### PREVENTION OF VENOUS THROMBOSIS

It is well established that there are many factors which influence the return of blood

from the deep veins of the extremities. The action of the heart and squeezing action of the muscles of the legs are the two most important factors. Gravity may either hinder or accelerate the return of blood from the extremities to the heart.

not believe that this is the final answer to the problem since many surgical patients who are active and ambulant from the day of operation have still developed signs and symptoms of a venous thrombosis. Patients with extensive fractures or severe trauma to the lower ex-

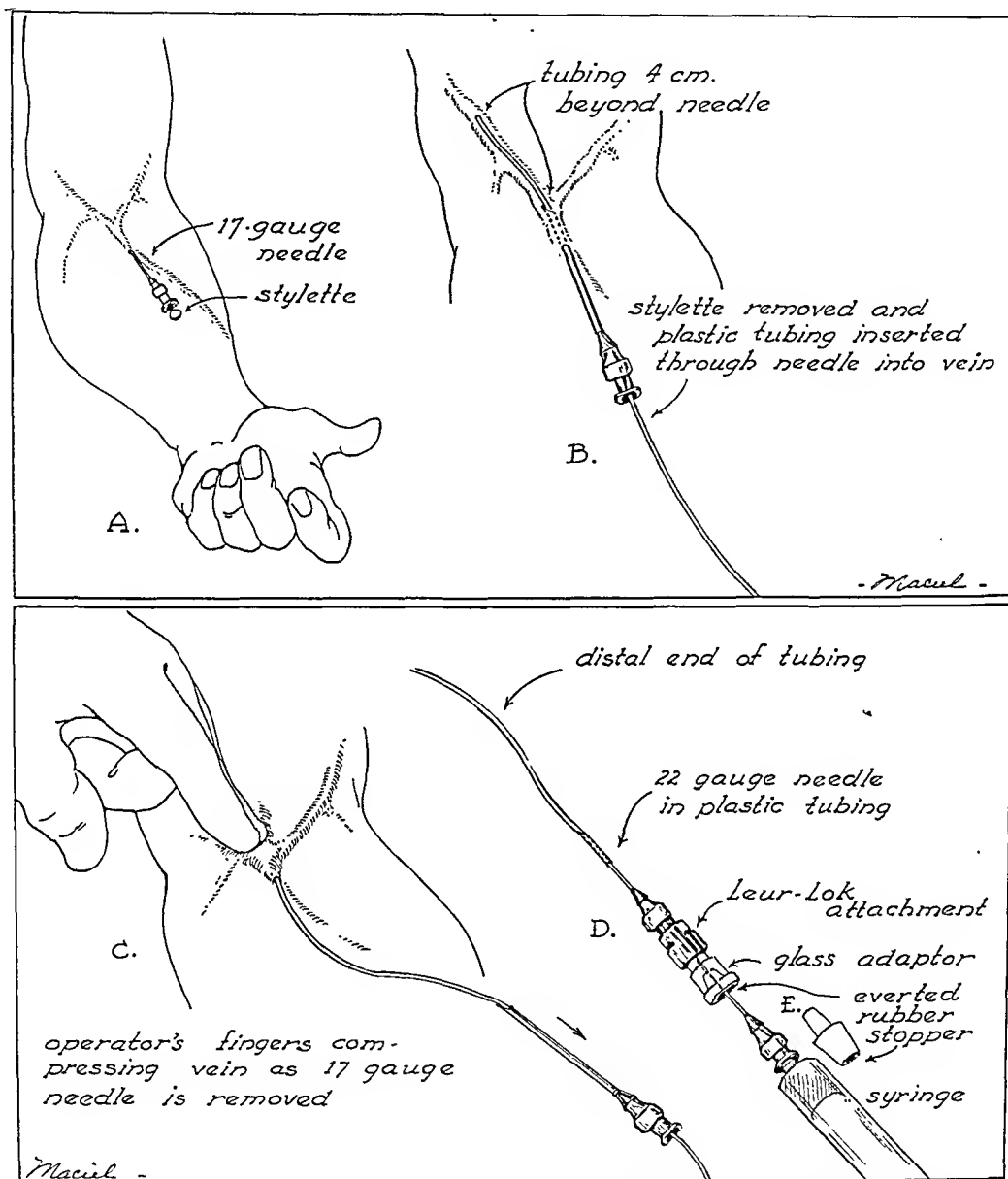


FIG. 1. A, a 17 gauge needle is inserted into a vein of the forearm; B, the stylet is removed and the polythene plastic tubing is threaded through the needle into the lumen of the vein; C, digital pressure is applied over the plastic tubing while the 17 gauge needle is removed; D, a 22 gauge needle with Leur-Lok attachment and glass adaptor is inserted into the free end of the plastic tubing. Heparin is injected through the rubber stopper.

Most surgeons are cognizant of the importance of early mobilization of patients as a means of combating the retardation of the flow of blood from the extremities. We do

not believe that this is the final answer to the problem since many surgical patients who are active and ambulant from the day of operation have still developed signs and symptoms of a venous thrombosis. Patients with extensive fractures or severe trauma to the lower ex-

the venous return from the lower extremities. DeTakats<sup>7</sup> has emphasized the importance of including the pelvis in this postural drainage. Those patients who are in modified Russell's skeletal traction are encouraged to perform the usual quadriceps muscle exercises as well as exercises of the anterior and posterior tibial muscle groups. Patients whose lower extremities are immobilized in plaster casts should still be able to carry out exercises of the toes.

Smith and Allen<sup>8</sup> showed that the temperature of the skin has an important influence upon the return of venous blood from an extremity. The flow was decreased when the skin was cool and greatly accelerated when it was warm. They also showed that two minutes of active movement of the muscles of the leg while the patient was in the supine position hastened the return of venous blood. Similar results were obtained by raising the extremity to an angle of 30 degrees.

#### METHODS OF TREATMENT

Once thrombosis of the peripheral veins takes place the objects of treatment are to limit the extension of the process of thrombosis, to prevent fragments of the blood clot from becoming dislodged, to prevent pulmonary infarction and to correct local impairment of the venous circulation in the affected extremity.

At the Cincinnati General Hospital we have adopted the use of the anticoagulants heparin and dicumarol as our primary measure of therapy for venous thrombosis. We believe that elevation of the involved extremity as well as absolute bed rest during the initial period of anticoagulant therapy, followed by ambulation when the local signs have subsided are valuable adjuvants in treatment of this condition.

As soon as the diagnosis of venous thrombosis is made the coagulation time (capillary tube method) and prothrombin concentration (Quick's method) on peripheral venous blood is determined. If the values are within normal limits, heparin and dicumarol are administered.

Heparin is given by the intravenous route in doses of 50 to 75 mg. every three or four hours depending upon the sensitivity of the patient to this substance. We have found that the utilization of polythene plastic tubing which was made available to us by Dr. Kenneth Thompson of the Roche-Organon Company

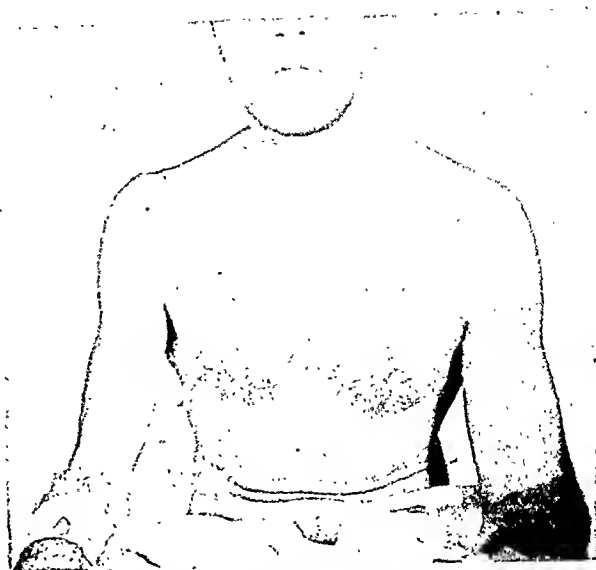


FIG. 2. The plastic tubing has been inserted into a right forearm vein, the attachments added and anchored with adhesive tape.

has simplified this intermittent intravenous administration of heparin. This method consists of inserting a 17 gauge needle with stylet into the antecubital vein. (Fig. 1.) The stylet is withdrawn and the polythene plastic tubing is threaded through the needle into the lumen of the vein. The needle is withdrawn and the polythene plastic tubing is allowed to remain within the vein. The tubing is anchored to the skin with adhesive tape after a small piece of gauze has been placed at the site of perforation of the skin. (Fig. 2.) A 22 gauge needle with Luer-lock and rubber stopper attachment is inserted into the lumen from the free end of the polythene plastic tubing. The air is removed from the rubber stopper attachment and heparin is injected by means of an ordinary hypodermic needle and syringe. This method offers several advantages over the usual method for intermittent injection of heparin, the most important of which is the ease with which the nurses may give the heparin intravenously at regular intervals. Because of lack of adequate nursing help, continuous intravenous administration of heparin has been discontinued in our clinic.

When the initial prothrombin concentration is within normal limits we administer 200 mg. of dicumarol simultaneously with the initial dose of heparin and then give 200 mg. on the following day. Since the majority of these patients were in the older age group, we have tried to avoid any sudden increase in the blood volume with transfusions of whole blood to

counteract any hypersensitivity to dicumarol. Even though we have employed relatively small doses of dicumarol, we have been obliged to give synthetic vitamin K to counteract abnormal bleeding tendency. In one patient who showed abnormal sensitivity to this drug the prothrombin concentration dropped to 6 per cent of normal after the initial dose, and signs of bleeding became apparent. This patient also developed femoral nerve palsy which has persisted up to the present time.

On our service the duration of therapy is ten to fourteen days during which time the patient is made ambulatory if at all possible. If the patient is confined to bed because of the method used in treatment of the fracture, dicumarol therapy is continued for the duration of the period of bed rest. Under the latter circumstances prothrombin concentrations are obtained two to three times a week and a sufficient amount of dicumarol is administered to maintain a prothrombin concentration between 30 and 50 per cent of normal.

All but one of our patients received anticoagulant therapy; of those who received heparin and dicumarol the symptoms subsided within two to four days. Patients with pulmonary infarction did not show evidence of further pulmonary embolism on either physical or roentgenologic examination. One patient who had a fracture of the neck of the femur died with a massive pulmonary infarct. Owing to her feeble-mindedness and comatose condition for one week prior to death, the venous thrombosis was unrecognized. She refused to eat and developed, in addition, a mixed meningitis as an extension from a sacral decubitus ulcer.

#### SUMMARY

The causes or abnormal circumstances responsible for the intravascular clotting of blood are not yet fully understood. Workers in this field do, however, recognize the fact that the real solution to the problem lies in the prevention of venous thrombosis rather than in limitation of the process to the part of the extremity already affected. It is most important, therefore, to examine each patient carefully for evidence of venous thrombosis so long as he remains bedridden.

Among patients with fractures of the lower extremities there is a high incidence of elderly people who are particularly susceptible to the

development of venous thrombosis. Since the occurrence of deep venous thrombosis is so closely related to inactivity and recumbency, early and continued active motion while the patient is still in bed is an important prophylactic measure. Measures preventative of stasis of blood in veins of the lower extremities such as frequent change of position, elevation of the foot of the bed and, most important, movement of the muscles of the lower extremities must be carried out.

Once peripheral venous thrombosis has occurred early recognition of its presence is essential to proper therapy. At present we believe that limitation of the disease process to the affected extremity and the prevention of pulmonary embolism is best accomplished by the use of anticoagulant therapy.

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#### DISCUSSION OF PAPERS BY DRs. BREIDENBACH AND LORD AND AURIN AND HERRMANN

LOUIS G. HERRMANN (Cincinnati, Ohio): Dr. Breidenbach and Dr. Lord have rightfully emphasized the importance of early recognition of injuries to large blood vessels in any form of trauma. It is

also important that whenever possible the continuity of blood vessels be re-established as quickly as possible, for every hour that passes after complete arterial occlusion or cessation of arterial circulation to the various parts of the extremity increases the hazards.

There are some exceptions to this, and Dr. Breidenbach probably did not have the time to tell them all. It is our belief that whenever blood collects under fascial planes and causes a collapse or interference of the collateral circulation, immediate operation should be done even though the continuity of the artery cannot be re-established.

I do not entirely agree with Dr. Breidenbach or Dr. Lord in the management of arteriovenous aneurysm. We know that is a very powerful stimulant to arterial collateral circulation and it is not always possible to re-establish the continuity of the artery. Some people have tried to do so in the vein, and whenever veins are re-established under those circumstances, pulmonary embolism is a frequent complication. I should like to warn you that repair of veins, especially in arteriovenous aneurysms, is dangerous.

Dr. Breidenbach did not have time to say anything about the late effects of arterial injuries; the complications which follow injuries to large blood vessels sometimes come on very insidiously and they go unrecognized until some irreparable damage to the soft tissues of the extremity already have taken place.

Concerning Dr. Aurin's paper we are particularly anxious that early recognition of minimal types of venous thrombosis be made. We are sure that if treatment is instituted early, many of the serious complications can be avoided. Unfortunately, we do not see as much venous thrombosis in our own clinic as has been reported from some of the other clinics throughout the country. We are constantly on the lookout and, of course, in the management of fractures we see patients who have been exposed to trauma and therefore are ideal candidates for venous thrombosis.

At the present time we are interested in finding some adequate test for the susceptibility to venous thrombosis. The prothrombin test, even with concentrated plasma, does not give us the complete story as to which group of patients is particularly susceptible to venous thrombosis. It is our hope that some time in the near future a good test will be available so that elective operations can be postponed if the individual is in a phase of hypercoagulability of the blood.

CHARLES G. JOHNSTON (Detroit, Mich.): It is common practice in our hospital (and many times we are criticized for it) to re-suture an artery which might well be tied off without damaging the limb. We have gone on the major premise, in teaching, that the staff is there as teachers, the residents as surgeons, and that under those circumstances it

takes a great deal of time from the staff man because it means that he can do the operation in less time than the resident can. Nevertheless, as time goes on, these men get very agile and in some instances do the work quicker and better than even the staff man could.

It is the same in relation to arteries. We have made it a rule that any major artery that is cut must be sutured. When the resident first sutures an artery, even though he has had practice in the animal laboratory, he is somewhat concerned about it. I think it is pretty generally true that after one artery has been sutured successfully the confidence which is gained makes a great deal of difference.

It is very important primarily for the development of technic, because many limbs are lost because the surgeon believes that arterial suture is something that is strange, phenomenal, unusual and difficult to do.

We do not have all the equipment that Dr. Lord has presented. It is very nice to have it but one does not need all this equipment to do an arterial suture. I think this is important to point out. One does have to have some way of occluding the vessels and also suture material and needles which are of the proper size.

I have had no experience with Vitallium tubes in general, because I think the thing can be done just as well and just as easily without them. I see no need for Vitallium tubes and am opposed to the use of foreign bodies in places where straight grafts can be used. I much prefer to use a vein graft without the use of Vitallium tubes. I am of the same opinion in relation to the use of Vitallium tubes for restoration of the common duct.

One question I would like to ask is about removing the clot from the distal portion of the vessel. In a vessel that is injured the upper portion can easily be washed free of any clot and usually there is none there; but in the distal portion there is a tendency for clot formation. If this is not carefully removed, one finds later that thrombosis in the terminal vessels results.

It is sometimes exceedingly difficult to remove, in my experience, all the clot that is below. I would like to ask the authors what means or to what lengths they go to be sure that the distal portion of the artery is clear of clot?

In one instance we have made an incision further down in a patient who had his injury for some time in order to wash through from the suture site, so that all clots could be washed out. Even in this instance although we had removed clots from above the lower incision, opened the artery well down the leg and allowed blood to flow, we had a certain amount of thrombosis which developed in the terminal vessels.

GORDON MURRAY (Toronto, Canada): In the first paper on repair of vessels and grafts, I am entirely in accord with all the views expressed. I

would like to emphasize this point: When an extremity is injured and there is a huge hematoma with obliteration of pulse distally, it should be explored under average conditions. It should be determined at the time whether the vessel is completely divided or not and an appropriate repair carried out.

We are interested in sewing vessels and in putting grafts to bridge gaps. What is the fate of those grafts? I have some information that has come to hand recently concerning the survival of grafts. I put a venous graft in a brachial artery eleven years ago and it is working well at the moment. Another graft in a popliteal artery twelve years ago was 5 inches in length, and I have reason to believe it is still working well. Another graft in a femoral artery has been working for ten years. This boy went into the Army, went overseas, returned and is still well. This graft has stood him perfectly well.

These among many others have been under observation recently and there is no sign of giving way of the graft; there is no aneurysm, degeneration or calcification that can be felt or seen on x-rays. However, probably the best evidence is an experimental graft which I put in the carotid artery of a dog. With good care he lived for nine years. We got that graft a few weeks ago after the dog died of old age. The lumen was patent and a little larger than the adjacent artery, but it was functioning normally. There was some calcification and some bone in one part of the wall; otherwise it was clear inside. The endothelium looked normal and it was functioning normally after nine years.

Regarding the second paper on venous thrombosis by Drs. Aurin and Herrmann, again I am entirely in accord with their opinions. It is my view that venous thrombosis occurs more commonly than it is considered by staffs in hospitals.

Regarding the prevention of embolism following thrombosis, I have some very definite views based on the following evidence. Some believe that vessels should be tied off early either before or after operation to prevent embolism. I have now seen three patients who died of proven pulmonary embolism following simple ligation of the saphenous vein in Scarpa's triangle for varicose veins.

Another patient recently sent to me had had a hysterectomy and the surgeon had tied off her veins as a precaution. Having anuria, she was sent to me for treatment with the artificial kidney. To get into the vena cava we opened the veins that had been tied off as a precautionary measure to prevent embolism. As I took off the ligatures and went through the saphenous bulb and into the femoral vein, I pulled out a clot on the left side a foot long that had extended through the femoral vessels and into the vena cava. The operation that had been done to prevent such a condition had probably caused it.

We probably all agree that at operation the tying off of any vessel is the site at which thrombosis must necessarily begin, but how far it extends no one can tell. At any rate, in these cases the ligation of vessels was one factor in producing thrombosis and intravascular clotting.

Therefore, I am very much of the opinion that the treatment for thrombosis and pulmonary embolism is anticoagulants. I am somewhat prejudiced in favor of heparin but we use dicumarol as well. I hope the day may come when it will be possible to give anticoagulants as a prophylactic to patients susceptible to thrombosis.

JOHN A. CALDWELL (Cincinnati, Ohio): I have gone through the experience over a long time of watching venous thrombosis gradually develop. It is detected first when the thigh gets large and painful and the patient exhibits a rise in temperature.

Since we have become thrombosis-conscious, it is a common thing after watching the patient and looking at the condition to note the tenderness in the calf of the leg, the presence of a positive Homans' sign and so discover the condition early, and as a result to get the patient convalescent very much sooner. It has been a distinct contribution to our handling of these cases and I wish to testify to that particularly.

In discussing the first paper Dr. Herrmann quoted me as giving him information about damage to the popliteal artery associated with the displacement of the lower epiphysis of the femur. I should like to call further attention to this and give warning because in both of them the children who had this condition lost their legs. Where the lower epiphysis separates, it is nearly always displaced anteriorly and this displacement stretches the popliteal artery over the ragged edge of the upper fragment. If this condition is not relieved promptly the continued pulsation of the artery over the ragged edge will gradually wear it in two.

In both the cases which I have seen (these were not mine originally) the restoration of that displacement was delayed long enough to permit the catastrophe to take place, and when it does happen it is a real catastrophe.

HOWARD SNYDER (Winfield, Kan.): Arterial injuries were very important subjects in military surgery. Fortunately, we had the opportunity of using some of the Lord-Blakemore tubes in the Mediterranean theater. Dr. Allen O. Whipple was responsible for having some of them sent to us early, and our own Ordnance Department made us a lot of these tubes, so that a number were used.

We found it rather difficult to evaluate results. The artery injured, the extent of the damage to collateral circulation and concomitant wounds in the same extremity certainly influenced the prognosis and result.



Dr. F. A. Simeone, I am told by Dr. Lord, has reported on a series of these cases in the Mediterranean theater. It was hard to say from the first dozen of these cases whether or not we were improving our results with the Lord-Blackmore tubes. One of the complications occurred that Dr. Lord mentioned: A vein graft blew out about two days after the graft was made. That case would have been one of the good results but with reoperation the limb was lost.

One of the things that must be considered in the use of a graft is the fact that the added manipulation may further interfere with the collateral circulation. I think whenever one of the operations is attempted that should be kept in mind, and trauma of the collateral circulation certainly should be minimized.

Popliteal injuries almost invariably resulted in the loss of a limb if arterial continuity was not restored, and certainly in that case a graft should be attempted.

In wounds to the femoral artery the results were as good with ligation as they were with the use of the tubes in the cases I had an opportunity to observe. I hope Dr. Lord will tell me if this was not true in the total series of cases that Simeone reported.

Certain other things might be mentioned which are important in the care of these arterial injuries. Primary suture can be done successfully in the case of the popliteal artery even when there has been some loss of substance. Imes reported three cases in which he did a primary anastomosis and saved the limb. Lichtenstein called attention to another maneuver which may save life or limb, and that is the use of suture of the end of an artery rather than ligation to preserve collaterals which may be close by. He called attention to that procedure in the management of wounds of the larger arteries in the neck.

Sympathectomy was made almost a routine procedure following these vascular injuries. A slightly dependent position of the limb, careful attention to other wounds of that extremity and the use of fasciotomy or long incisions through the skin and fascia to decrease tension in the affected limb were thought to be of value in the management of these cases.

JERE W. LORD, JR. (New York, N. Y.): The successful management of arterial anastomosis rests on the basic triad: proper vascular equipment, "know-how" of arterial anastomosis and practice and experience. Many successful anastomoses have been done by the surgeon who has improvised his equipment at the time, and have also been done successfully when the surgeon has had no previous experience but has done it at the time because of necessity. In general, however, the ideal is to have

the equipment available in every hospital where it is necessary to carry out these procedures, and, secondly, have a surgeon on hand who is experienced with the technique; this, of course, is most important.

In addition to having the equipment and the experience, technical proficiency can be obtained in the department of experimental surgery so that each surgeon interested in this subject will be prepared to handle this emergency in hospitals which do not have a large volume of clinical material of this sort.

LESTER BREIDENBACH (closing): It is true that in most injuries that occur the surgeon attempts to tie the artery; and in the one case we cited in which this accident happened in the course of a herniotomy, it was the first experience we had had in going back late after the artery had been ligated.

Due to technical errors it was not successful but that sort of procedure can be done in spite of the fact that the limb, as Dr. Snyder mentioned, may not be gangrenous when the injury is high up on the femoral artery. The limb may be saved but usually the function is badly impaired. The individual can walk for only a short distance without claudication and pain. Efforts should be made in late cases in which the limb has been saved and the function impaired to re-establish anastomosis and the use of the artery.

Dr. Aurin mentioned some of the late results and he does bring out the fact that the vein graft arterializes beautifully. On microscopic examination it is very difficult to distinguish the vein graft from an artery.

We have felt so strongly about this that the New York and Brooklyn Regional Committee on Fractures and Other Trauma, under the chairmanship of Dr. Wade, has developed a brochure with instructions to surgeons on the management of these particular injuries, with all their ramifications, the method and equipment.

In answer to Dr. Johnston's question I wish to state that on the removal of thrombi from the distal end of the artery, a great deal has to do with the time factor. If the injury is seen very early, there is not much chance for thrombosis and it does not extend very far. We dissect the distal end of the artery as great a distance as we can from the site of the injury, put a rubber-shod clamp or two turns of umbilical tape to prevent thrombi from going distally and then thoroughly irrigate that artery. In spite of that, as Dr. Johnston has brought out, we are not always successful in removing all of the clots; but that has been the best method, thoroughly irrigating with a stop somewhere down low in the artery, that is, as low as one can possibly get.



# LOCAL APPLICATION OF ALUMINUM FOIL AND OTHER SUBSTANCES IN BURN THERAPY\*

W. A. BROWN, M.D., A. W. FARMER, M.D. AND W. R. FRANKS, M.D.

Toronto, Canada

THIS paper deals chiefly with the results of investigation directed toward improvement of the local therapy of thermal burns. Because of the encouraging observations noted on the application of aluminum foil as a primary dressing, this section of the work is described in detail. In addition, mention is made of three other studies. (1) use of titanium dioxide exposure cream as a topical application for thermal burns. (2) use of massive doses of ascorbic acid in the early therapy of acute burns and (3) blood glutathione levels in children following acute burns.

## ALUMINUM FOIL THERAPY

It is possible in deep second degree burns that maceration of the burn surface may result in the death of cells which might otherwise remain as islands of regenerating epithelium. Prevention of this maceration is considered to be an effort of some importance.

For centuries ointments of various types have been applied to burned surfaces. In many localities gauze impregnated with vaseline is employed as a regular procedure. Woven fabrics, used with or without ointments, may become soggy with exudate thus aiding in the production of maceration. On the other hand, a dry non-absorbent covering, virtually intact, may be of advantage because of these physical properties. Many metal foils may be suitable. As aluminum is non-toxic and the foil is plentiful, cheap and easy to sterilize it was the metal employed in most of the cases to be described.

Application of metal foil as a surgical dressing is far from new and dates back at least to the time of Lister<sup>1</sup> who advocated the use of tin foil or sheet-lead from tea chests as a covering for wound dressings. More recently Davis<sup>2</sup> has applied foil to freshly grafted areas and Harkins<sup>3</sup> describes the use of silver foil on donor areas and grafts.

\* From the Department of Surgery, Hospital for Sick Children and the Royal Canadian Air Force, Institute of Aviation Medicine, Toronto, Canada.

*Physical Properties.* Pure aluminum foil is a bright metallic sheet which, at a thickness of .001 inches, can be readily molded on the contours of the body surface and removed with the dressings at ten days. Thicker foils were found to be more unwieldy at the initial dressing. On the other hand, foil as thin as .0004 inches has been used and although it could be applied with ease fragmentation occurred under occlusive pressure dressings, with the result that its removal piece by piece from the burn surface on the tenth day was tedious. Lately use of this thin aluminum foil has been reserved for application on fingers and hands, in which case the ease of application in the treatment of children has far outweighed the inconvenience of piecemeal removal.

As a result of the process of manufacture as well as the manipulation in handling all foils were found to be permeable sheets. Pin holes transmitting light could readily be seen when a sheet was held up to a source of light. To test for permeability to liquids aluminum foil, .001 inches in thickness, was molded into the form of a flask and filled with water. Numerous small drops appeared immediately on the exterior at the sites of these tiny apertures. No samples were found to be water-tight.

*Method of Application.* The standard method adopted for application of aluminum foil to the burn surface at the initial dressing is as follows:

1. Following adequate sedation, the burn area is cleansed under aseptic precautions with 1 per cent aqueous cetyl-trimethyl-ammonium bromide (cetavalon); sluiced clean with saline and blotted dry with a sterile towel.

2. Dry aluminum foil which has been sterilized by autoclaving is smoothed by hand onto the burn surface and is extended at least 1 inch beyond the burn on the undamaged skin.

3. The routine pressure dressing is then applied over the foil. This includes voluminous

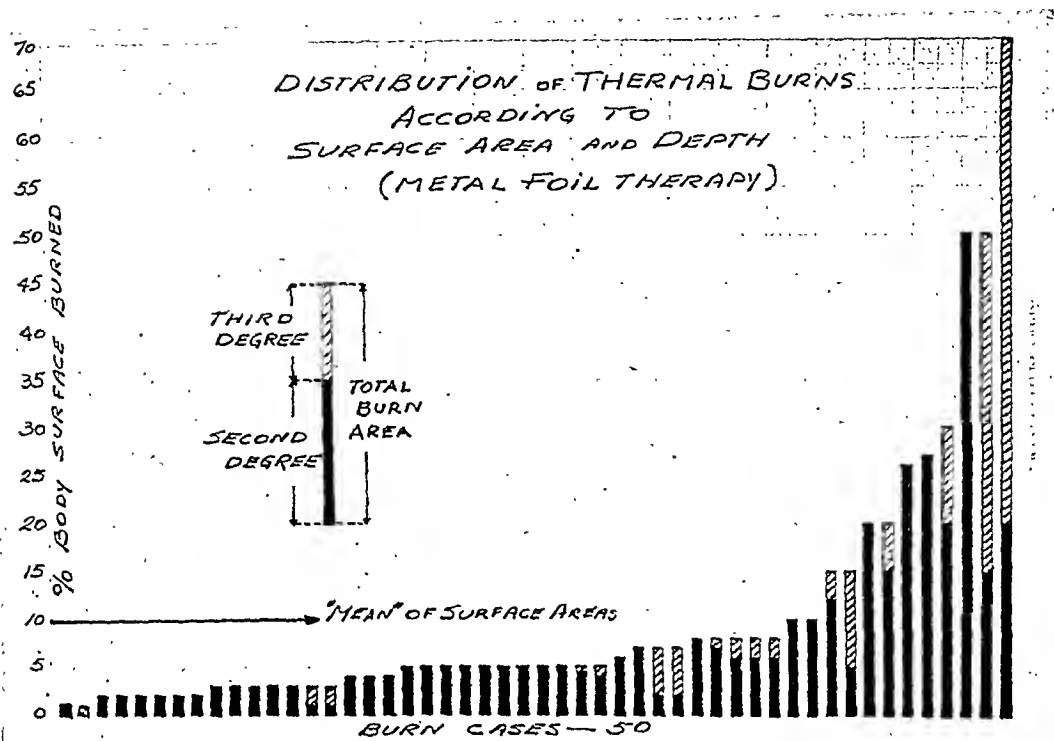


FIG. 1. The area and depth of the injury to each of the patients on whom metal foil was applied is indicated in this diagram.

fluffed-out gauze and burn pads with bias flannelette bandaging. In order to ensure immobilization in children light plaster casts complete the dressing when indicated.

**Results.** To date fifty children have been admitted to the hospital for Sick Children, Toronto, Canada, for whom aluminum foil\* has been used as an initial dressing for thermal burns. In some cases gold leaf, silver leaf, tin foil or tantalum foil supplemented the aluminum foil on a portion of the burn surface. The ages range from five months to thirteen years, with burns of varying size and depth from 1 per cent second degree to 70 per cent second and third degree. Erythema was not included in the estimation of the burn surface area. Using the burn classification of three degrees, rather than Dupuytren's classification, the distribution of the burns according to body surface area and depth is recorded in Figure 1.

Many factors, such as the area, depth and condition of the burn surface as well as the type of local therapy, play a part in the systemic reaction of a burned patient. For clarity in the analysis of the problem the local and

systemic aspects of the cases will be dealt with separately.

#### INFLUENCE OF LOCAL THERAPY ON THE BURN SURFACE

In thirty of the fifty cases which were studied approximately similar results were found at the ten-day redressing on removal of the foil from burns which were second degree in depth only. The burn surface was pink, dry and found to be healing by epithelization without evidence of the maceration so often found with ointment dressings into which exudate has soaked.

The aluminum foil maintained its dry metallic sheen on both surfaces. The gauze dressings protected by the foil were unstained except for small spots of dried brown exudate which on occasion had penetrated the tiny apertures in the foil. At the periphery of the foil some exudate was seen in the voluminous gauze dressings resting on normal skin. This exudate was dry, scant, brown in color and had evidently flowed laterally by capillary action between the foil and the body surface. The observation that the exudate had dried emphasized that the weeping from the burn surface had ceased some days prior to the first redressing. The ten-day dressings were practically odorless.

\* Aluminum foil was supplied by Dr. Dudley Irwin of the Aluminum Company of America. The product referred to as 2S-O, contains 99.3 per cent reduced aluminum, 0.1 per cent silicon and the remainder being iron except for traces of copper and manganese.

For purposes of comparison vaseline gauze and aluminum foil were placed contiguously on a portion of the burn surface in three of these patients, resulting in a clear cut line between the two forms of local therapy. At the ten-day period moist exudate continued to soak the fabric, and maceration of tissues under the vaseline gauze was distinctly noticed in contradistinction to the dry healing surface under the foil.

In one case, for further comparison, dry nainsook was likewise applied to an area surrounded by aluminum foil. As compared with the dry clean epithelization of the area under the latter the area under the nainsook showed a sharp contrast with adherent heaped-up exudate and the material itself was soaked with moist exudate. This served to demonstrate the fact that the vaseline application *per se* is not exclusively the factor causing maceration.

In nine further cases the local results at ten days warranted a common description of the burn areas which were third as well as second degree in depth. On removal of the foil the second degree areas were dry and healing. The third degree areas were covered with a thin, moist, grey layer of slough. The skin surface of the aluminum foil was slightly moist but the bright metallic sheen was unchanged. The gauze dressings contained a moderate amount of dried brown exudate at the periphery, but the gauze protected by aluminum foil was clean. This group included one burn of third degree depth over 35 per cent of the body surface with an additional 15 per cent second degree. As in the smaller burns of this group this case revealed no evidence of the foul-smelling exudate which would almost certainly have been a feature of ointment dressings in burns of this extent and depth.

In three further cases including burns of second and third degree the dressings were extensively soiled with urine by the tenth day. The skin surface of the aluminum was moist and the overlying gauze was soggy. The dressings had a foul uriferous odor. Burn areas of third degree depth were covered with thin, moist slough while second degree areas were likewise moist but healing with pink epithelium. There was no clinical evidence of infection. The third degree areas corresponded in extent to the areas suspected to be full thickness burns at the initial dressing and following

repeated applications of sodium hypochlorite solution, 1:12, the areas were grafted.

An additional two cases included second degree burns of the hands which were treated by application of aluminum foil with individualization of the fingers. The tenth day redressing disclosed marked maceration of the burn surface, and the superficial skin layers were wrinkled, soggy and whitened. These results were in contradistinction to ten other cases of hand burns which have been included in the large group of second degree burns with dry cleanly-healing results at ten days. The reason for the maceration in these two burns is believed to be due to failure to apply adequate pressure with the bulky mitt-like dressings.

In one further case aluminum foil was applied to second degree burns of a leg and the overlying dressings were deliberately applied with minimal pressure. The burn continued to weep through the voluminous gauze which was reinforced on two occasions. The burn surface at the tenth day was moist and moderately macerated and the dressings contained more than the usual amount of exudate.

One further case was a deep second degree complete facial burn in a fifteen months old child. Aluminum foil was applied over the entire surface, including the eyelids, and covered with voluminous dressings, leaving an opening for the mouth. Because of concern for the eyes, redressing was performed at the fourth day. The entire skin surface of the foil at this time was found to be wet as a result of lacrimation and seepage under the foil. Moist brown stains were scattered on the overlying dressings where the fluid had penetrated the apertures in the foil. The gauze dressings at the margins of the foil were likewise moist. The burn surface was pink and healing cleanly except for a grayish-brown covering on the upper eyelid areas. Aluminum foil was reapplied, leaving the eye areas uncovered. By the tenth day epithelization was progressing satisfactorily and cleanly except for crust formation on the upper lids. Satisfactory healing was eventually completed without the necessity of grafting. Among the second degree burns with dry cleanly healing results was included a similar full facial burn in an older child, and the eyelids were not covered in this case at the initial dressing. Four other second degree burns involving partial facial areas

only were also included in the same group just described. One full facial third degree burn treated with local application of aluminum foil was included in the large group of third degree burns which have been described. The result was indistinguishable from the third degree burns elsewhere on the body, and grafting was done at the sixteenth day with a complete "take," including the eyelid areas.

One of the remaining patients suffered third degree burns over 50 per cent of his body surface and second degree burns over an additional 20 per cent. Although the dressings overlying the aluminum foil were quite dry at ten days and compared favorably with the previously mentioned description of the group of nine second and third degree burns, this case differed in that the burn surface was covered with a leathery green slough due to infection with *Bacillus proteus* and *B. pyocyaneus*, rather than with the thin, moist, grey slough which had been the usual result of third degree areas treated with local application of aluminum foil. This was the one case in which gross clinical evidence of infection was found in these fifty cases. Extensive bacteriologic studies of the organisms on the burn surfaces have not been possible, and stress instead has been laid on clinical evidence of pathogenicity rather than bacteriologic evidence of contamination.

In one of the remaining cases dry cellophane was applied to a portion of the burn surface for purposes of comparison with aluminum foil applied elsewhere. At the tenth day the cellophane was soggy and adherent to a thick layer of slough. The dressings at the periphery were soaked with foul-smelling exudate which had extended by contact to the layers of gauze overlying the peripheral portion of the cellophane. Only the central portion of the overlying gauze was clean by reason of the distance from the periphery and the protection from direct penetration afforded by the cellophane barrier. By comparison with the result of the use of aluminum foil on this and comparable cases it was evident that cellophane was unsatisfactory and its use was eliminated from the series of cases.

One of the two remaining cases was a small second degree burn which was treated with aluminum foil and the patient was discharged prior to the ten day redressing. The patient failed to return for the tenth day appointment

and the result was presumed to have been satisfactory.

The final case to be considered was a small third degree burn caused by an exploding fire-cracker. The initial dressing was aluminum foil. The burn area was excised and grafted on the fourth day in order to shorten the clinical course. At this stage the dressings were dry, the burn area was without exudate and a central black area had the appearance of dry gangrene. Healing following grafting was uneventful.

#### ALUMINUM DUST AS A LOCAL APPLICATION

Because of the simultaneous interest in the preparation of a combined exposure cream and burn ointment to be used as an initial emergency measure by air force personnel, aluminum dust was briefly investigated. By a process of Soxhlet extraction with acetone followed by desiccation dry aluminum dust was obtained from aluminum paint.\* In the process the aluminum lost a great deal of its bright sheen due to formation of oxide. The aluminum dust (reduced aluminum plus oxide) was sterilized by dry heat and applied to a superficial second degree burn with a result at ten days equal to areas covered by the foil. On one additional third degree burn the dust formed an adherent eschar with the surface slough and exudate which was slow in separating under dressings of sodium hypochlorite 1:12. Whereas third degree areas treated initially by aluminum foil were ready for grafting by the eighteenth day, the areas covered with aluminum dust were delayed an additional two weeks.

There was no evidence of local or general toxic reaction to the aluminum dust which was used. The possibility of the occurrence of the phenomenon of tattoo due to application of the dust to burns of deep second degree depth was discussed but was not encountered as this type of burn was not included in the two cases studied.

#### LOCAL APPLICATION OF GOLD LEAF, SILVER LEAF, TIN FOIL AND TANTALUM FOIL

Gold leaf and silver leaf were obtained as extremely thin fragile sheets which were difficult to handle because of their static elec-

\* Supplied by Dr. Dudley Irwin of the Aluminum Company of America.

trical charge. This caused them to adhere to objects which they contacted when being applied to a burn surface, with resultant fragmentation at the slightest touch. Tin foil, containing 2.5 per cent lead, and tantalum foil were similar in appearance to aluminum foil.

For purposes of comparison portions of the burn surface of nine patients treated with aluminum foil were covered with one of the other four metals and second and third degree areas were included in the comparisons. The local results at ten days in eight cases were equal to the remaining areas covered with aluminum foil and separate descriptions of the burn areas are unnecessary. The gold and silver leaf at ten days was found to be finely fragmented and adherent to the dressings except for scattered traces remaining on the burn surface. The tin foil and tantalum foil were removed intact and unchanged in appearance.

In the other of the nine cases gross infection by *B. proteus* and *B. pyocyaneus* was present at nine days under the aluminum foil in the extensive burn case previously described while an area covered by gold and silver leaf totalling 5 per cent of the body surface was covered with a firm adherent brown eschar of surface slough and exudate in which was incorporated the fragmented metal. Further comparison with regard to separation of the areas under sodium hypochlorite dressings was terminated by the death of the patient on the twelfth day.

#### INFLUENCE OF LOCAL THERAPY ON THE SYSTEMIC REACTION TO THE BURN

In order to evaluate the effect of aluminum foil therapy on the systemic reaction mention must be made of other therapy employed. According to the indications in an individual case, the following outline of treatment was followed: (1) Antitetanus serum 1,500 or 3,000 units and scarlet fever antitoxin 3,000 units were given to all patients. (2) All burns involving 10 per cent of the body surface or more received plasma as well as some burns of lesser extent. The amount of plasma was judged on the basis of the extent of the burn and the hemoconcentration as determined by repeated hemoglobin estimations using the photo-electric colorimeter. (3) Burn patients in whom 10 per cent or more of the body surface was involved as well as those with lesser surface area burns but third degree in depth received a high caloric, high protein diet with added

multiple vitamins and iron. Otherwise the patients received the regular ward diet. (4) Fluids were administered freely by mouth, and additional parenteral fluids were administered when necessary to correct or prevent dehydration. (5) Intramuscular penicillin therapy was decided upon for each individual patient and not used routinely. (6) Blood transfusion was reserved for severe secondary anemia.

Clinical experience with many hundreds of burn cases at the Hospital for Sick Children has shown that the supportive therapy used was adequate for burns involving less than 10 per cent of the body surface. In this group marked systemic reaction was not encountered. Of the fifty cases thirty-eight are included in this group and no evaluation of the effect of aluminum foil therapy on burn illness can be made. These cases were of value in disclosing the absence of abnormal systemic or local reaction to the aluminum foil itself.

Twelve cases are included in the group of burns involving 10 per cent or more of the body surface. Of these, one patient only progressed through a severely toxic stage and eventually succumbed on the twelfth day to burns covering 70 per cent of his body surface including 50 per cent third degree. Of the remaining eleven patients none gave cause for alarm by reason of general signs or symptoms during the critical period of the first week. In two cases involving 50 per cent of the body surface these were considered to be much milder than was expected with other forms of local therapy despite the most rigorous general supportive measures.

Outlines of the clinical courses of the three patients with the most severe burns are as follows:

#### CASE REPORTS

**CASE I.** A twenty-three month old boy sustained a scald which involved 50 per cent of his body surface in third degree burns and 20 per cent in deep second degree burns. On arrival at the hospital a profound state of shock responded immediately to intravenous plasma and two hours after admission, under morphine sulfate gr.  $\frac{1}{12}$  (S.C.), the burns were dressed with aluminum foil except for a 5 per cent surface which was covered with gold and silver leaf. During the first twenty-four hours the patient vomited once and never thereafter. His extremities were warm. His pulse rose to 124/minute and respirations were as high

as 60/minute but they were shallow and effortless. Plasma was continued to a total of 1,750 cc. and was followed by Ringer's lactate.

The course of his illness, subsequent to the first twenty-four hours, was definitely a toxic one. He became difficult to arouse, respirations remained accelerated but without evidence of true dyspnea and his temperature rose to as high as 105°F. For forty-eight hours marked oliguria was accompanied by albuminuria, 2 plus urobilin and gross hemoglobinuria which were followed by diuresis and clearing of the urine. Sporadic twitchings of his extremities became frequent. There was edema of the dependent portion of his scalp and the serum proteins fell to 5.3 Gm. per cent with an albumin/globulin ratio of 1. A marked secondary anemia required transfusion. On the ninth day, at the height of a consistently rising septic type of fever, the burns were redressed, hypochlorite solution 1:12 being applied. From the third degree areas covered with green slough *B. proteus* and *B. pyocyaneus* were cultured.

During the following three days this patient's condition continued to deteriorate and death ensued on the twelfth day. No single cause of death could be determined at postmortem which disclosed early bronchopneumonia, extensive infection, acute left otitis media and several erosions of the gastric mucosa.

It is perhaps worthy of note that at no time was cyanosis present, no frank convulsions developed and no vomiting recurred despite administration of high protein, high calorie gastric feedings by continuous drip.

CASE II. A four and one-half year old boy was treated with aluminum foil dressings two hours after sustaining deep second degree burns over 50 per cent of his body surface. General supportive measures were carried out as first outlined. His subsequent clinical course was mildly toxic. He remained alert throughout, urinary output was unimpaired and urinalysis disclosed 4 plus albumin on the day following the burn but subsequent urinalyses were normal. Fluids and high protein, high caloric diet were tolerated without vomiting. One rectal temperature reading of 104°F. on the first day was followed by fever below 103°F., with a normal temperature from the ninth day on. One unusual pulse reading of 160/min. occurred on the sixth day. Serum proteins were depressed to 4.2 Gm. per cent by the seventh day but rose again to the initial level by two weeks. During the first ten days this patient was quite comfortable considering the extent and severity of the burn and his subsequent course was uneventful with rapid healing by epithelization.

CASE III. A seven year old girl sustained third degree flame burns over 35 per cent of her body surface and second degree burns over 15 per cent of her body surface; they were treated by the ap-

plication of aluminum foil. The initial hemoconcentration was corrected by 1700 cc. of intravenous plasma during the first forty-eight hours. During this time her extremities were cold and cyanotic and vomiting occurred several times. No other general signs were noted. From the third day of her illness she tolerated a high protein, high calorie diet without recurrence of vomiting. During the first ten days her temperature rose to 103°F. on one reading and as high as 102°F. thereafter. One pulse reading of 160/minute was obtained on the fourth day but otherwise the pulse chart of the first ten days was indistinguishable from the chart of the subsequent months of her illness. Dyspnea was not observed. By the eighth day a secondary anemia had developed and she required a transfusion. Serum proteins remained above 5 Gm. per cent and there was no inversion of the albumin/globulin ratio. Urinary output was slightly impaired only and urinalysis disclosed 3 plus albumin on the second day, subsequent occasional traces and occasional red blood cells and white blood cells on microscopic examination.

Grafting was begun on the eighteenth day and was completed by multiple stages during the subsequent four months.

The remaining nine of the twelve patients with burns of 10 per cent or more of their body surfaces showed little or no evidence of general illness except for febrile reactions. A large series of cases of more severe burns will be required from which to draw conclusions but to date burn patients appear to pass through a milder stage of systemic reaction than one has been accustomed to see in comparable patients using other forms of local therapy.

#### FACTORS TO BE CONSIDERED IN INITIAL ALUMINUM FOIL THERAPY

Several possible factors are under consideration which might, in part at least, account for the apparent favorable results from use of aluminum foil as an initial application for fresh thermal burns.

1. By virtue of the heat-reflecting property of aluminum foil heat conservation may favorably influence the course of the illness.

2. Fluid which weeps from the burn surface contains protein in proportions approaching that of plasma, and the desirability of its conservation is obvious. Aluminum foil, by providing a physical barrier under adequate pressure, appears to diminish the surface weeping as compared with other forms of local therapy. In twenty-five of the fifty patients weighed dressings were applied which were

reweighed at ten days before and after drying, followed by determination of the content of water-soluble exudate. In twenty of these cases adequate occlusive pressure dressings were applied over the aluminum foil. In five cases voluminous dressings were deliberately

TABLE I  
ALUMINUM FOIL OCCLUSIVE PRESSURE DRESSINGS

Per Cent Burn Area, Degree of Depth	Initial Weight of Dressing Applied (Gm.)	Weight Gain in Ten Days "Wet Exudate" (Gm.)	Weight of Water-soluble Dry Exudate (Gm.)	Quotient Dry Exudate (Gm.) Burn Area (Per Cent)
15-II	446.0	274.0	25.5	1.3
5-III				
5-II	182.1	15.2	7.0	1.4
3-II	220.8	2.3	2.3	0.8
20-II	968.4	151.4	77.4	2.9
10-III				
5-II	216.8	306.8	22.8	2.9
3-III				
8-II	242.4	56.1	17.9	2.3
4-(II)	243.9	40.9	12.6	3.1
(III)				
3-II	153.6	17.3	3.95	1.3
20-II	.....	.....	64.9	0.9
50-III				
7-II	268.0	61.3	10.4	1.5
8-II	381.4	202.4	25.1	3.1
2-II	.....	.....	2.98	1.5
4-II	166.9	26.0	8.46	2.1
8-(II)	285.4	118.4	12.0	1.5
(III)				
6-II	369.2	95.8	14.9	2.5
26-II	663.3	299.2	70.0	2.7
8-II	.....	.....	8.04	1.0
7-(II)	375.3	116.0	16.59	2.4
(III)				
12-II	581.6	205.3	36.2	3.0
5-III	371.2	152.6	28.2	4.0
2-II				

Aluminum Foil Occlusive Dressings with Inadequate Pressure

3-II	147.0	30.8	20.86	6.9
5-II	629.0	110.5	22.24	4.5
5-III	408.6	76.6	19.8	4.0
4-II	375.4	74.5	25.44	5.1
10-III				
3-(II)	353.5	94.1	16.4	5.5
(III)				

applied with minimal or inadequate pressure. The results of this work are included in Table I.

The rise in the value of the quotient (weight of dry exudate in Gm. divided by per cent of

surface area burned) in those patients treated by inadequate pressure illustrated the value of occlusive pressure dressings in burn therapy. The value of pressure over aluminum foil was further emphasized in three of these patients by the observation of maceration and failure of dispersion of the exudate.

The weight of wet exudate in some cases, as noted in Table I, was disproportionately large owing to marked contamination by urine, but this factor did not grossly influence the value of the quotient.

A similar series of weighed dressings and exudate extractions, using an ointment burn dressing instead of aluminum foil, will be required for comparison if the observation is to be substantiated that aluminum foil is of value in diminishing the surface weeping.

It has been considered that the maintenance of a dry dressing barrier offers a defense against bacterial invasion during the first ten days as compared with the portal of entry provided by a dressing which becomes soggy following some forms of local therapy.

The possibility has been considered that the reducing properties of aluminum foil may be an advantage in detoxifying, by reducing back, the abnormal oxidized products formed as a result of the burn.

#### ALUMINUM FOIL IN THE LATER TREATMENT OF BURNS

Aluminum foil was reapplied at the tenth day as well as subsequent dressings to the sloughing surface of a third degree burns. This area, as compared with other areas treated by sodium hypochlorite solution 1:12, was slow in reaching the stage at which grafting could be done. In two cases aluminum foil was applied to granulating areas awaiting grafting by multiple stages. No bleeding was encountered when the areas were uncovered. The granulations themselves appeared slightly paler than usual and were covered with a thin, glairy secretion. Grafts took well on these areas in both cases.

In two cases aluminum foil was applied as a dressing over the paraffin mesh used to fix fresh partial-thickness grafts. The results were satisfactory and the dressings were removed easily without trauma. The results of application of aluminum foil to two donor areas compared favorably with the standard scarlet R dressing.



## TITANIUM DIOXIDE OINTMENT

Investigation of the use of titanium dioxide ointment as a local application for fresh thermal burns was initiated through the necessity of procuring a combined exposure cream and burn ointment. The formula for the ointment was obtained from a report<sup>4</sup> submitting its use as a means of allaying the pain of thermal burns. The ointment itself was made up on a special order and is a creamy white mixture consisting of six main ingredients:

	Per Cent
Titanium dioxide (TiO <sub>2</sub> ).....	10
Wool fat.....	15
Vaseline.....	5
Lanette wax.....	10
Glycerine.....	25
Manucol.....	35
Drop of 0.1 per cent chlorocresol as preservative.	

Lanette Wax<sup>5</sup> is largely stearyl alcohol with 10 per cent partial phosphate stearyl and cetyl alcohols. Manucol is sodium or calcium alginate. Titanium dioxide itself is a highly insoluble stable substance found chiefly in ilmenite ore commercially but universally present in small amounts in the earth's crust and in various tissues of the body. In the ointment this ingredient gives protection against sunburn by virtue of its opacity.

Prior to the use of this ointment on a fresh burn the toxicity of titanium dioxide was in question while the other ingredients were considered innocuous. A survey of the literature revealed no report of toxic reaction to TiO<sub>2</sub> while Huggins<sup>6</sup> and others declared that it was found to be non-toxic despite large intravenous injections into experimental animals.

By reason of its known highly insoluble nature it was considered that ingestion by phagocytosis rather than absorption would be the mode of entry of titanium dioxide, if at all, into the body of a burn patient. Even the most sensitive chemical methods of determination<sup>7</sup> of TiO<sub>2</sub> were obviously not applicable to the necessarily small blood samples which could be obtained from children, and microscopic detection of titanium dioxide in the phagocytes of the peripheral blood of burn patients treated with the ointment was attempted instead. In order to recognize the substance an intravenous injection of a rabbit was carried out, and the particles were readily visualized using blood smears stained with Leishman's

stain. The particles appeared singly and in clumps, chiefly in the cytoplasm of the polymorphonuclear leukocytes, but occasionally in the monocytes. Four and one-half months later this animal showed no gross or microscopic evidence of disease when autopsied and the titanium dioxide at this time was visualized in the fixed and wandering cells of the reticulo-endothelial system in the liver, spleen, lung and bone marrow. In the lung TiO<sub>2</sub> was evidently being eliminated from the body in the bronchial secretion in the process demonstrated by Irwin.<sup>8</sup>

In the clinical series of burn patients treated with titanium dioxide ointment, smears of capillary and venous blood were examined repeatedly without the discovery of any cell containing the particles. It was considered that phagocytosis of the particles at the burn surface was slight and if it did occur the phagocytes were not recovered from the blood before becoming fixed in the reticulo-endothelial system.

*Influence of Titanium Dioxide Ointment on the Burn Surface.* The ointment which was spread on nainsook was applied to a portion of the burn surface in six clinical cases and to the donor area from which a partial-thickness graft had been removed in one case. The usual scarlet R dressing was applied to the remainder of the donor area and vaseline gauze or aluminum foil supplemented the dressing of each burn.

No abnormal systemic reaction to the use of the ointment was noted, but the local result was disappointing. Although its use as an application for allaying the pain of thermal burns had been advanced,<sup>4</sup> 50 per cent of the burn patients in our series complained of pain localized to the area covered with the titanium dioxide ointment. This symptom began after a comfortable latent period of twenty-four hours or more and was a spontaneous complaint repeatedly accurate as to the area involved. Control dressings were consistently comfortable.

At the ten-day redressing three cases of superficial second degree burns were healing equally as well as the control in each case. The donor area, likewise, gave an equally good result. Two patients with deep second degree burns showed evidence of irritation. Healing of the areas which had been treated by titanium dioxide ointment eventually was completed by epithelization but was much retarded as com-



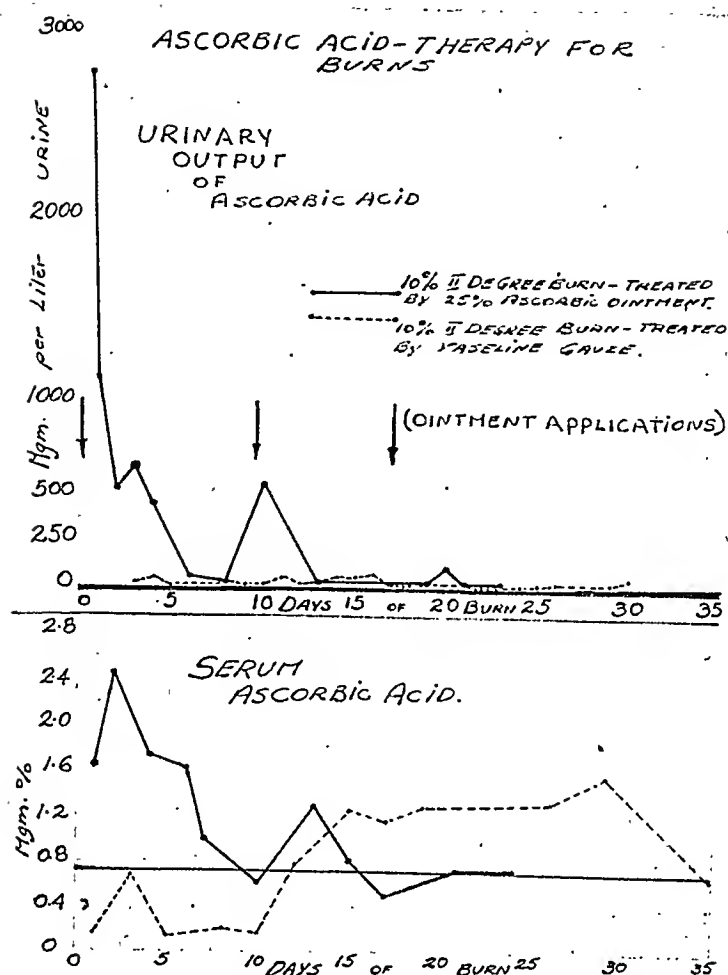


FIG. 2. The urinary output and blood levels of ascorbic acid from two patients burned to an almost similar area and depth. One of these was dressed with 25 per cent ascorbic acid ointment and the other with vaseline gauze.

pared with the control therapy. This was clearly demonstrated at three weeks in one of the cases in which a clear cut band of crust formation across the lumbar region, exactly coinciding with the area dressed with the ointment, was in sharp contrast to the cleanly healed burn above and below which had been treated with aluminum foil.

As well as delay in healing one final case demonstrated the possibility of the irritating factor being active in conversion of a deep second degree burn into a third degree area requiring grafting. Although indistinguishable from other areas initially, the area under titanium dioxide ointment at the tenth day showed evidence of irritation as compared with the remainder of the burn and a small central area eventually granulated and required a small partial-thickness graft.

Because vaseline gauze was used as well as aluminum foil to demonstrate the unfavorable comparable result, some factor other than maceration is believed to be responsible for the production of pain, the delay in healing and the damage to epithelial remnants.

#### ASCORBIC ACID THERAPY FOR BURNS

As Andreae and Browne<sup>9</sup> reported a very low ascorbic acid plasma level and marked reduction in the urinary output of the acid following burns the hypothesis was suggested that ascorbic acid, by virtue of its redox potential, might reduce and thereby detoxify abnormal oxidation products formed as a result of the burn. Were this hypothesis true the marked disappearance of ascorbic acid would be explained, and it was postulated that prevention of toxemia might be accomplished by

administration of ascorbic acid in quantities adequate to detoxify, by reducing back, the major portion of such substances. This portion of the work was carried out with the cooperation of Dr. K. F. Clute during 1946 to 1947.

Twenty burn patients were treated with massive doses of ascorbic acid. The therapy in some cases was confined to an ascorbic acid ointment with eucerin base while other patients were treated by dressings of a 5 or 10 per cent aqueous solution of ascorbic acid supplemented by oral therapy.

The low urinary output of ascorbic acid and the low plasma level were overcorrected to well above normal ranges within a few hours. Several Gm. of ascorbic acid were excreted in the urine in twenty-four hours, with concentrations of the acid in the urine as high as 10.4 mg./cc. In Figure 2 the ability of ascorbic acid ointment on the burn surface to raise the plasma level and urinary output is compared with a control case of equal body surface involvement in which vaseline gauze was applied and no ascorbic acid was administered except the usual amount added to the hospital diet. The great absorptive power of a burn surface is well illustrated.

Despite the rapid correction of ascorbic acid depletion, the general signs and symptoms in severe burn patients were not influenced to an appreciable degree. This opinion differs from that of Einhauser who, Harkins<sup>10</sup> relates, found vitamin C advantageous in prolonging the life of animals burned experimentally and later extended his observations to patients, with good results.

Ascorbic acid ointment has been found to be of value as a topical application to third degree areas from which slough is slow in separating under sodium hypochlorite solution 1:12. Speedy separation of slough has been noted following application of the ointment. The immediate production of pain was a consistent feature of the local application of ascorbic acid ointment or the aqueous solution to fresh burn surfaces. Undesirable general systemic reactions to the administration of massive doses of ascorbic acid were not encountered in this series of twenty patients.

*Control Cases.* In thirty-five burn patients treated by other than ascorbic acid applications the urinary output of reduced ascorbic acid was repeatedly determined from freshly voided specimens. Plasma levels of total ascorbic acid

were followed in seven cases and single estimations were obtained in an additional four. The results of this work were consistent with the findings reported by Andreae and Browne.<sup>9</sup>

#### INFLUENCE OF THERMAL BURNS ON BLOOD GLUTATHIONE

Glutathione normally plays an enzymic rôle in aerobic intracellular oxidation, reduction in the body. The variation in blood levels following burns was studied as a result of the simultaneous interest in ascorbic acid metabolism, both glutathione and ascorbic acid being members of the redox system.

In the blood stream glutathione is present in the red blood cells only and is found throughout various body tissues as well. The reduced form (GSH) is a sulfhydryl tripeptide of glutamic acid, cysteine and glycine; the oxidized form (GSSG) observes and S-S linkage of two molecules, with the loss of one hydrogen from each sulfhydryl radical. The estimation of this substance in the venous blood of children was carried out by the iodometric titration method of Woodward and Fry.<sup>11</sup>

Venous blood samples were drawn from eight burn patients at daily or bidaily intervals throughout their period of hospitalization. One late burn patient who arrived at the hospital on the thirtieth day with a cleanly granulating burn surface and one normal adult were followed as controls. Serum ascorbic acid levels were determined on each specimen in order to investigate the possibility of a relationship between the changing levels of these two members of the redox system. Because the glutathione is contained within the red blood cells only and since the estimations were carried out on whole blood, red blood cell counts and hemoglobin estimations were carried out on each specimen of blood in order to correct for hemoconcentration as a result of the burn and hemodilution as a result of plasma therapy, each of which would impose an apparent variation in glutathione levels during the illness.

*Results.* Cicala<sup>12</sup> and Titone<sup>13</sup> individually reported an initial increase in glutathione in the blood following thermal burns. This increase may have been largely due to the influence of hemoconcentration on the glutathione determinations.

In our series of eight patients glutathione showed an irregular fluctuation within the

normal limits established by the determination of the glutathione content of the blood of twenty normal children. The two control patients showed a similar day-by-day fluctuation. Blood glutathione was not found to be influenced by thermal burns and no consistent relationship to the serum ascorbic acid levels was found, either during the stage of ascorbic acid depletion or following the rise of serum ascorbic acid to normal limits.

#### SUMMARY

1. Aluminum foil as a dry sterile initial covering for thermal burns under occlusive pressure dressings has been presented as a method of diminishing the maceration of a burn surface. The method appeared to influence favorably the local result by elimination of the use of ointments and by facilitating the dispersion of exudate to the periphery of the burn. No evidence of toxicity as a result of the treatment was found. The systemic reaction was, if anything, less obvious.

2. Titanium dioxide exposure cream as a burn ointment was considered to be irritating from the evidence of production of pain, delay in healing and possible destruction of epithelial remnants.

3. Massive doses of ascorbic acid administered to burn patients quickly corrected the state of ascorbic acid depletion, but the general systemic reaction to thermal burns was not found to be influenced by this form of treatment and the general signs of illness were marked in severe cases.

4. Blood glutathione levels were not found to be influenced by thermal burns within the limits of the method of determination employed and bore no consistent relationship to changes in serum ascorbic acid levels.

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#### DISCUSSION

GROVER C. PENBERTHY (Detroit, Mich.): Local application of aluminum foil in a fresh burn is another contribution to the treatment of very serious lesions. Dr. Farmer and his associates are to be congratulated on their continued interest in trying to promote better treatment for the severely burned patient.

This appears to be an ideal local application. From the standpoint of acting as a covering of the burned area, no doubt relieving the patient of pain, pain being one of the disturbing and very annoying complications and aspects of the burn lesion, this use of aluminum is something that I think all of us will be interested in. He has shown by a comparative study of the various local applications that the aluminum foil has merit.

I would like to ask Dr. Farmer if he thinks there is antibacteriostatic or bacteriocidal action in the use of the aluminum? He reports the lesions as being fresh and pink at the end of ten days, in contrast to that type of lesion treated by dry gauze or by vaseline gauze. I recall many years ago as an intern in New York that we used a solution called aluminum acetate. I have not seen aluminum acetate used in many years but I recall vividly how that was used as an antiseptic solution in the treatment of infected wounds and as a substitute for boric acid or saline.

A. W. FARMER (closing): Thank you, Dr. Penberthy.

The only question Dr. Penberthy asked concerns the bacteriocidal action of aluminum. We know nothing about it. That entered our minds and further investigation will have to be done on the subject but I cannot give you any data on it at all.

# HERNIATION OF FASCIAL FAT\*

## A CAUSE OF LOW BACK PAIN

DENMAN C. HUCHERSON, M.D. AND JOE R. GANDY, M.D.

*Houston, Texas*

IN 1945 Herz<sup>3</sup> described a condition causing low back pain which he attributed to painful fatty tumors of the back. He reported six cases, all in women, in which the removal of these fatty masses completely relieved the symptoms. A year earlier Copeman

and Ackerman<sup>1</sup> reported ten cases (all British soldiers) in which fatty tumors were excised from the back, with striking relief. These authors also dissected fourteen backs and concluded that the palpable masses were herniations of fat through the fascia of the back. These latter two authors in 1947 reviewed their cases and reported an additional twenty-one.<sup>3</sup> They were still enthusiastic about the procedure and suggested that the herniations might occur elsewhere in the body. Since the publication of these papers, we have operated upon forty-two patients with painful palpable masses in the low back and we have corroborated the

findings of Copeman and Ackerman to our satisfaction.

### CLINICAL ASPECTS

All of our patients have complained of backache of varying degree and intensity

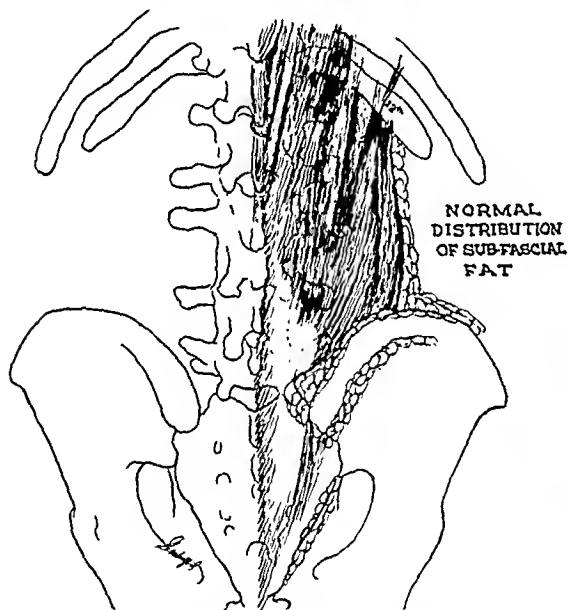


FIG. 1. Diagrammatic representation of the normal distribution of subfascial fat according to Copeman and Ackerman.

and Ackerman<sup>1</sup> reported ten cases (all British soldiers) in which fatty tumors were excised from the back, with striking relief. These authors also dissected fourteen backs and concluded that the palpable masses were herniations of fat through the fascia of the back. These latter two authors in 1947 reviewed their cases and reported an additional twenty-one.<sup>3</sup> They were still enthusiastic about the procedure and suggested that the herniations might occur elsewhere in the body. Since the publication of these papers, we have operated upon forty-two patients with painful palpable masses in the low back and we have corroborated the



FIG. 2. A fat herniation removed from patient in Case 8. Note the edematous appearance of the fat globules. This section is larger than average but shows the typical appearance. The scale is in millimeters.

which they were able to localize fairly well within a definite area. Frequently the pain was referred, being sciatic in distribution or radicular in character. Three patients complained of testicular pain. Palpation of the mass always caused the patient to wince involuntarily and most often the referred pain was reproduced or intensified by this pressure. These trigger points tend to occur in predictable sites which Copeman and Ackerman refer to as a "pain pattern." This pattern follows from above downward the lateral border of the sacrospinalis muscle from the costal margin to the crest of

\* From the Department of Orthopedic Surgery, Baylor University College of Medicine, and the Southern Pacific Hospital, Houston, Tex.

TABLE I

Name	Age	Sex	Symptoms in Months	Location	Radiation	Comment	Result
1. D. A. T.	28	M	48	Iliac crest bilateral 2 in. from midline	To anterior abdominal wall	Complete relief	Excellent
2. H. G. B.	40	M	$\frac{1}{4}$	Inferior to iliac crest, left	Sciatic to knee, left	Complete relief	Excellent
3. J. O. M.	40	M	18	2 nodules inferior iliac crest, right	To right hip	Complete relief	Excellent
4. J. H. H.	61	M	18	Superior crest ilium, left	To left testicle	Complete relief	Excellent
5. T. H. L.	49	M	60	Lateral to right posterior superior spine	To right thigh and right testicle	Complete relief	Excellent
6. R. J. G.	34	M	48	Superior to right posterior superior spine	To right testicle	No relief, later had laminectomy and spine fusion, without complete relief of symptoms	Failure
7. L. L. N.	55	M	48	Inferior to left iliac crest	Sciatic to knee, left	Complete relief	Excellent
8. G. E.	33	M	48	Inferior to right iliac crest	Lateral aspect of right thigh	Complete relief	Excellent
9. A. M. T.	47	F	54	Level 4th lumbar, bilateral	None	Pain not as noticeable but dull low back pain at times	Fair
10. D. R. W.	20	M	9	3 cm. lateral to right sacroiliac joint	To right knee	Complete relief	Excellent
11. M. M. H.	27	F	$\frac{1}{4}$	Right sacroiliac joint	To front of abdomen	Complete relief	Excellent
12. H. A. S.	55	M	12	Inferior to right iliac crest	Sciatic to right calf	Complete relief	Excellent
13. R. A. S.	53	M	1	Inferior to left iliac crest	Lateral and anterior surface of left thigh and knee	Complete relief	Excellent
14. G. D. N.	40	M	36	Inferior to right iliac crest	Lateral surface, right thigh	Complete relief	Excellent
15. L. C.	45	M	6	Bilateral, lateral to posterior superior spine	None	Patient a physician; after one year stated he was 80% improved	Good
16. N. C.	30	M	3	Lateral posterior superior spine, left	Sciatic to left knee	Complete relief	Excellent
17. D. W. W.	55	F	6	Lateral posterior superior spine, left	None	Complete relief	Excellent
18. J. R. B.	20	F	5	Lateral posterior superior spine	None	Complete relief	Excellent
19. H. M. O.	40	M	6	Lateral posterior superior spine, right	Sciatic	Had previous laminectomy without relief; returned to heavy work after fat pad removed	Excellent
20. M. W. U.	50	M	5	Inferior posterior superior spine	To left thigh	Fat pad not identified at operation; fat in region excised; mild backache still present but no radiation	Fair
21. L. D. J.	40	M	$\frac{3}{4}$	Inferior iliac crest, bilateral	None	Complete relief	Excellent
22. M. B.	38	M	2	Over crest ilium, left	Sciatic, left leg	Complete relief	Excellent

TABLE I (Continued)

Name	Age	Sex	Symptoms in Months	Location	Radiation	Comment	Result
23. F. B. A.	43	M	1	Lateral border sacrospinalis, left	None	Complete relief	Excellent
24. C. J. P.	37	M	24	Inferior iliac crest, right	Numbness right leg	Complete relief	Excellent
25. J. M. C.	43	M	12	Iliac crest, right	Sciatic to right knee	Complete relief	Excellent
26. J. B.	37	M	6	Inferior iliac crest, bilateral	None	Mild pain 2 mo. after surgery, followed by complete relief	Good
27. L. D. W.	47	M	1/2	Inferior iliac crest, right	None	Complete relief	Excellent
28. U. B.	57	M	1	Superior to posterior superior spine, left	None	No preoperative x-ray; no relief of symptoms; postoperative x-ray revealed metastatic lesion of 5th lumbar vertebra; died 1 mo. later	Failure
29. W. L.	56	M	2	Inferior to posterior superior spine, right	None	Complete relief	Excellent
30. H. H. N.	53	M	6	Inferior to iliac crest, right	To right thigh	Severe pain and backache relieved; still has occasional mild backache	Good
31. L. J. L.	43	M	6	Superior posterior superior spine, right	Sciatic radiation, right	Complete relief	Excellent
32. S. D. C.	18	M	1	Inferior iliac crest, right	To anterior surface, right thigh	Complete relief	Excellent

the ilium. In the gluteal region the points are found about the posterior superior spine, along the crest of the ilium and about 5 cm. below it. They are also found along the line of the sacroiliac junction but are not commonly found elsewhere in the buttock. These points correspond to the normal distribution of fat beneath the posterior fascia. (Fig. 1.)

Injection of the painful nodules with 1 per cent novocain will afford temporary relief and should always be carried out as a diagnostic procedure.

We have not seen any sensory changes, reflex phenomena or muscular weakness associated with this condition.

#### CLINICAL PATHOLOGY

Copeman and Ackerman classify these fat hernias into three anatomic types: the pedunculated, non-pedunculated and foraminal. The names are self-explanatory except for the last mentioned. The cutaneous branches of the posterior rami of the last three lumbar nerves

pierce the deep fascia through definite foramina and fat globules may protrude through these foramina producing typical herniations.

Microscopic examination of the tissue from all the cases here reported was done by the Pathology Department of Baylor University College of Medicine. All of the sections consisted entirely of normal adipose tissue. None showed evidence of edema or inflammatory reaction. Nerve tissue has been observed in some of the sections but the finding has not been consistent. (Fig. 2.)

#### OPERATIVE TECHNIC

The skin is infiltrated with 1 per cent novocain in a transverse line over the nodule. After cutting through the skin and superficial fascia, the mass will usually pop into the wound and it will as a rule be larger than was expected from preoperative examination. The herniation is removed by blunt and sharp dissection; and if there is any doubt as to the limits of the mass, the surrounding fat should be freely

removed. Bleeding should be meticulously controlled as formation of hematomas will delay the patient's convalescence and mask the result. The wound is closed with interrupted sutures and a rubber tissue drain is left in place for forty-eight hours.

Only a local anesthetic should be used for the patient's pain perception is valuable in locating the herniation. In two patients who were given a general anesthetic the masses could not be identified.

#### CASE REPORTS

In Table 1 thirty-two cases are presented. All the cases in this series have been followed from six months to two years. Ten cases were excluded from this report as they have been followed less than six months. In these ten, however, the results have so far been excellent.

#### SUMMARY AND CONCLUSIONS

We have briefly reviewed the work of Herz, Copeman and Ackerman and presented thirty-two cases operated upon by us.

In the clinical cases described in this paper twenty-eight were male and four were female. The patients varied in age from eighteen to 61 years. There was no characteristic body type but none was extremely obese. In all but seven of our cases we have considered the results excellent. Five of these seven patients believed that they had experienced enough relief to warrant the operative procedure. One failure was due to inadequate work-up; the other failure we cannot explain.

We believe that herniation of fascial fat is one more definite cause for back pain that has been added to our knowledge of this perplexing problem.

It is hoped that this paper will stimulate interest in this condition, but we would like to caution against overenthusiasm so that this procedure may not fall into the disrepute of some of the other operations employed for the relief of certain types of low back pain.

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#### DISCUSSION

CHARLES FRANCIS WOOD (Louisville, Ky.): I must confess that I have never recognized this condition, if indeed I have ever seen it. Certainly it is an interesting condition; and I believe that if it does add one more weapon to our armamentarium for the treatment of lame low back with or without radiation, it will be a good thing.

I have been rather impressed with the localization of most of these masses in the region of the posterosuperior iliac spine. I worked with Dr. Clarence Heyman of Cleveland when he was doing his work on his posterior fasciotomy, and it seems to me that the localization of pain in these two conditions is just about the same.

Furthermore, I like these authors to be definitely commended for cautioning against overenthusiasm for this or any other single procedure for the relief of these patients. I do not think we can treat them until we diagnose them. If we examine them carefully and diagnose them accurately, I think we will find many procedures which will relieve some cases if they are properly selected.

FREDERICK REICHERT (San Francisco, Calif.): I would like to point out that the essayist mentioned referred pain, and I am curious as to why this referred pain should come from this little fat pad.

He mentioned rightly that he now has been using procaine in his injections. We have used the fine needle and accurately located the trigger spot, and with 2 per cent procaine (not 1 or 1½ per cent but, for some reason, 2 per cent which is much more specific) we have been able to relieve them permanently of their pain by injecting these trigger spots.

It is curious, too, that the trigger pains may be between the spinous processes, L-4, L-5 and S-1. There seem to be no blood vessels there, but there certainly are sympathetic fibers. I think this referred pain is due to irritation of the sympathetics that are in this fat pad that you cannot stain when you are studying your sections. If you will accurately attempt to find these trigger spots and inject them with 2 per cent procaine—and, more important, to hold and massage these areas afterward for ten or fifteen minutes so that there is no evidence of hemorrhage which would make the patient worse, you may be able to save him from an operation.

WILBERT HERSMAN MCGAW (Cleveland, Ohio): We all know that there are many causes of backache; and if we can place one finger accurately on one cause, I think it is a real contribution to the whole problem of back pain. Dr. Hucherson has approached this subject in a very scientific manner. Being from Cleveland, we have heard about Dr. Herz's work. I have also had the privilege of seeing some of his patients before and after surgery and I

am sure that many of them have had relief. However, I do believe that a complete study of any chronic back case is indicated.

I have used procaine injection in these painful areas and have noticed that at times a procaine wheal is as effective in giving relief as trying to infiltrate the base of the tender area.

I would like to ask Dr. Hucherson whether or not he has operated on any patients without first using procaine, or if he believes that procaine injection is an adequate test or indication as to the success of surgery? I would also like to ask him if he believes that these fatty masses arise from under the deep fascia? I was not sure whether or not he goes through the deep fascia to relieve the hernial opening if there is one.

DENMAN C. HUCHERSON (closing): In reply to the question concerning injection of these painful nodules I would like to emphasize that we customarily inject them all as we not only consider it a diagnostic procedure but also believe that a great many patients are entirely relieved of their symptoms by injection. In our clinic where the majority of these injections have been done, we have been unable to follow the cases with sufficient efficiency to allow us to arrive at any reasonably accurate estimate of those cured by injection. It would be my estimate that about only one case

in four requires surgery. We usually recommend removal of the herniation if the pain recurs after about the third injection.

Dr. Herz, who was to discuss this paper but could not be present today, has written me that he has a series of 229 of these cases. He has carried out injection routinely and has found it necessary to operate upon only sixty-seven. I believe this ratio will be found to be about normal.

We are asked, in relation to the fascia, where these masses are found. They are found beneath the subcutaneous fat of the back. The masses arise from the potential space formed by the superficial and deep fascia of the back.

As far as the rent in the fascia is concerned, we do not attempt to close it but rather enlarge it and remove all the fat in the area.

We have no explanation for the mechanism of the pain. We have been very pleased with, what we consider, the very excellent results in this series. I think it most important to mention that most of these patients we reported on today were operated upon at the Southern Pacific Hospital at Houston which is a railroad hospital. These men are all industrial cases and the compensation angle is involved. All of the patients classified as having excellent results have returned to full duty, many of them to section labor.





# AMPUTATION OF EXTREMITIES

S. A. SWENSON, JR., M.D. (*by invitation*) AND J. DEWEY BISGARD, M.D.  
Omaha, Nebraska

AMPUTATIONS of extremities are becoming increasingly more frequent with the advent of more modern mechanized living. During the past war about 17,000 individuals in the service of the United States underwent amputations of one or more

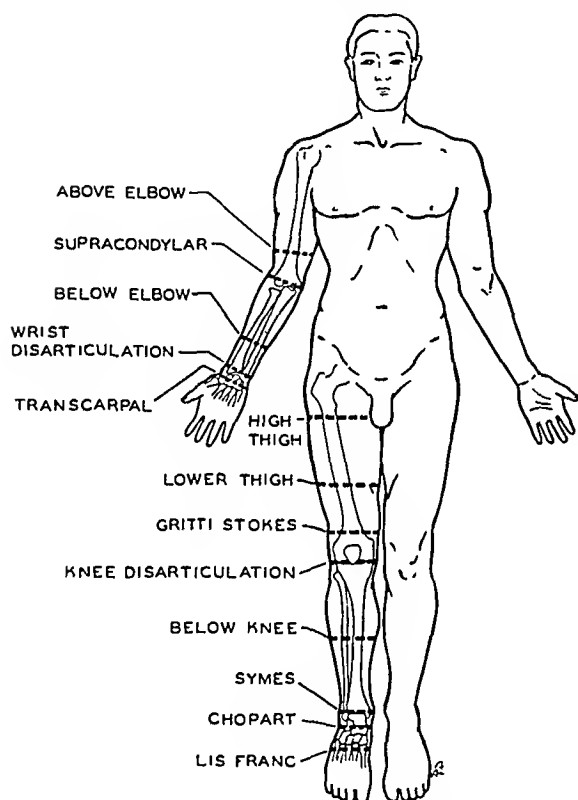


FIG. 1. Amputations; optimum levels.

extremities. Vital statistics reveal the fact that each year in the United States over 20,000 amputations of the extremities are performed in the civilian population. There is an increasing need for closer relationship between the surgeon, physiotherapist and the limb fitter. Experience gained in Army Amputation Centers during the past war has resulted in a better understanding of the physiology of the use of extremities, the technic to produce the most satisfactory stump and the proper fitting of improved prosthetic appliance and understanding of the problems of the amputee in general.

In civilian life, indications for amputations may be divided into four categories: trauma, circulatory diseases, neoplasms and congenital or acquired extremity deformities in which better function is possible with an artificial appliance. At present perhaps circulatory diseases are responsible for the greater percentage of amputations in civilian life; but with the rapid advance of mechanized living, especially in the middle western rural population, trauma is becoming a more prominent factor. Great progress has been made in fluid balance and anesthesia which has resulted in more radical surgical procedures for the removal of neoplasms of the extremities with increasing success in cures of long duration, and modern prostheses have been devised which aid these individuals to return to a useful life. Circulatory disease of sufficient severity to result in amputation is usually found in the age group over forty-five to fifty years. Most of the amputees of this last war were in the prime of life and growth, and the difference between these two age groups must be considered in the discussion of site of amputation, length of skin flaps and the fitting, wearing and education in the use of the prosthesis.

The primary aim of any amputation is first to eradicate the abnormal condition for which the amputation is indicated and, second, to produce an extremity stump which will be of greatest functional value when applied to the proper prosthesis. General points of importance include optimal levels of amputation, the shape of the stump (Fig. 1), proper placement of the scar, treatment of bone ends and treatment of nerves and other soft tissue structures.

Little time need be spent in discussion of proper or optimal levels of amputations. These have been well established by the vast experience gained in military and civil practice. There are, however, a few changing concepts which have been the result of recent progress in the development of prosthetic appliances.

## UPPER EXTREMITY

*Amputations below the Elbow.* Until the past war it was generally accepted that any

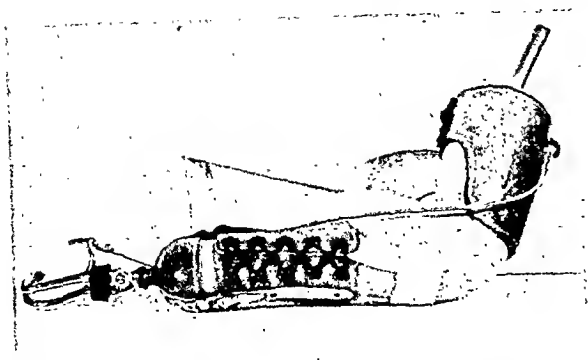


FIG. 2. Prosthesis for carpal-metacarpal disarticulation; developed by Comdr. T. J. Canty, Mare Island, California.

length beyond a 7 inch level in a forearm amputation was useless. Lately prostheses such as the one developed by Commander T. J. Canty at Mare Island Naval Hospital, California, have resulted in a definite indication for preservation of the carpal bones if possible. (Fig. 2.) This type of amputation, when applied to this prosthesis, results in a stump which retains all normal wrist functions, i.e., pronation and supination of the forearm, dorsi and palmar flexion of the wrist joint. It is not difficult to see that such a combination will give the amputee an extremity which will be of much greater use to him and will return him to a much more useful place in society.

Wrist disarticulations or even transcarpal amputations have been performed and have resulted in increased function when applied to proper prostheses. Previously it was difficult to fit such a stump so that the artificial hand or hook did not give the appearance of a longer forearm than the normal one. The wrist disarticulation, transcarpal or carpal-metacarpal stumps have proven particularly effective in patients with bilateral upper extremity amputations through increased function and applicability of the improved prosthesis. (Fig. 3.) The prosthesis usually does not extend above the elbow and is made of molded leather, closely fitting the contour of the stump. A bulbous bony stump such as results from a wrist disarticulation is then an advantage to keep the molded leather prosthesis from slipping off the stump.

A great deal has been written about cineplastic procedures for increased function in amputation stumps. A forearm amputation is probably the only one in which this technical refinement seems applicable. It must be remembered that no matter how strong a muscle

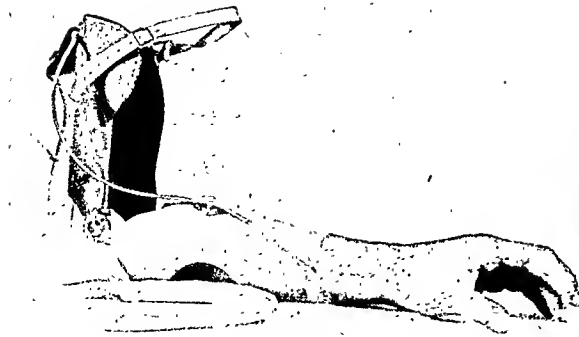


FIG. 3. Transcarpal amputation.

loop may be range of motion is limited. If range of motion is increased mechanically in the prosthesis, power must be sacrificed. Needless to say, this type of prosthesis is practically useless for any heavy work and therefore its application is limited to a relatively small number of amputees, particularly in the rural areas of the middle west.

There have been several recent improvements in technic of operation and development of prostheses for short, below-elbow stumps. The great flexor of the elbow, the biceps muscle, inserts on the radial tuberosity which in an average sized individual is about 1 to 1½ inches distal to the radial head. If the insertion of the biceps tendon is left in place, a 2 or 3 inch forearm stump is practically useless as a motor for a forearm prosthesis. A simple procedure in which the biceps tendon is transplanted from the radial tuberosity to the radial head or even the coronoid process of the ulna increases the functional length of the stump but, of course, decreases power of leverage and range of motion. A multiple action elbow joint has been developed for this type of stump in which, although the elbow can be flexed only to about 90 degrees, the elbow of the prosthesis will flex to the desired 30 degrees so that the mouth may be reached.

There has been a great deal of research and progress made in the development of upper extremity prostheses. Several ingenious mechanical hands have been devised but the usual difficulty is presented. With increased function there is a directly proportionate increase in mechanical complexity. Some types of mechan-



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FIG. 4. Forearm prosthesis with Northrup cable control and latex rubber hand.

FIG. 5. Forearm prosthesis with Northrup wrist control. Note position of stump socket in relation to supination of the hand.



FIG. 6. Elbow disarticulation.

ical hands would require the services of a fine watchmaker for repairs. Again it should be emphasized that the most efficient prosthetic appliances are the most simple in mechanical construction, and that an amputee must be able to get repairs for his prosthesis without sending it away for a long period of time during which he will be deprived of its use. A simple remedy, of course, is a spare limb but not every amputee is able to provide himself with such insurance.

Two of the finest developments in upper extremity prostheses which came out during the past war were the Northrup wrist joint and the Fitch elbow joint. The Northrup wrist joint provides the motions of pronation and supination with the use of the forearm stump as the motor mechanism. (Figs. 4 and 5.) The stump fits into a molded plastic cup which is attached to a mechanism which amplifies its motion to the hook or artificial hand in a ratio of about 1 to 3. Thus, if only 30 degrees rotation is possible between the bones of the stump,



FIG. 7. Above elbow prosthesis with the Fitch elbow joint.

90 degrees rotation is produced in the external appliance. This is extremely useful in fine motions of the upper extremity, well illustrated by drinking from a cup. If there is no pronation or supination in the wrist, all tipping motion must be transmitted through the elbow, shoulder and head.

*Amputations above the Elbow.* Elbow disarticulations were tried without too much success. An attempt was made to utilize the epicondylar flare of the humerus to produce a bulbous bony stump to which a molded leather cuff could be applied. (Fig. 6.) If practical, this would eliminate the cumbersome shoulder harness necessary to keep an above-elbow prosthesis from slipping off. In successful cases



FIG. 8. Short humerus stump with redundant soft tissue.

FIG. 9. Intramedullary fibular graft to lengthen short humerus stump.

it also provided stability in active motion and rotation of the humerus and the prosthesis. The main difficulty was in perfecting an elbow joint that could be locked in different positions of flexion and extension without making the upper arm part of the prosthesis too long.

The Fitch elbow is the only one to my knowledge that provides active control of flexion and extension. (Fig. 7.) It is controlled by antagonistic metal cables from opposite shoulder loops or anchors on the shoulder harness through the pulley-like mechanism illustrated. The only objection to this prosthesis was the lack of a lock for any set position, but this has probably been added since I last saw it.

Short humerus stumps are again a problem of insufficient length to provide adequate motor power for a prosthesis. Various plastic procedures, such as Z-plasty on the axillary folds and cutting of pectoralis and latissimus dorsi muscles, have been done with considerable success. Several cases have been recorded in which intramedullary grafts of fibula have been applied to short humerus stumps with skin. (Figs. 8, 9 and 10.) These have been successful, of course, only when there was adequate blood supply in the soft tissues to provide vascularization of the bone graft.

If at all possible, it is best to leave the head of the humerus in place on the glenoid fossa. This will result in a more rounded shoulder; and although most prostheses for amputations this high have only cosmetic value, it provides a stump which will fill out the shoulder of a coat without any appliance.



FIG. 10. Finished stump.

Prostheses have been devised for interscapulothoracic amputations but again these have little or no functional application and have only cosmetic value.

#### LOWER EXTREMITY

*Amputations through the Foot.* The most important requirement in amputations through the foot is an adequate plantar skin flap. A dorsal scar, placed where it is least subject to trauma, is an absolute necessity for a successful weight-bearing stump before anything else is considered. Phalangeal diarticulations, Lis Franc, Chopart, Pirogoff and, of course, the Syme amputations all fall into this category.

There have been few technical advances in amputations through the foot except for some minor refinements. In the shorter hind-foot



FIG. 11. Chopart amputation with ankle fusion and Gallie subastragalar stabilization.

amputations, such as the Chopart or Lis Franc, attempts have been made to stabilize the distal stump with tendon transplants or fusions. Actual bony fusion eliminates any motion in the joint, producing a club-like extremity, but is still the only adequate method for the prevention of everted equinus deformities in these stumps. Partial foot amputations are generally unsatisfactory and are difficult to fit but may be indicated in selected cases. (Fig. 11.) Figure 11 is the case of a man who suffered a traumatic amputation of the fore foot but as a bronco-buster in a rodeo desired to retain as much length as possible. Bony and soft tissue structures remaining permitted only a Chopart type amputation; therefore, to give him a stable stump an arthrodesis was done in the ankle joint and the subastragalar joint was stabilized by a Gallie type peg graft.

*The Syme Amputation.* The Syme amputation continues to grow in favor, particularly with the recent progress in the perfection of an adequate prosthesis for this type of stump. There is one very important point to be stressed in the technic of operation. It must be remembered that the shaft of the tibia is not at right angles to its weight-bearing surface; and when the malleoli are removed, the saw-line must be at right angles to the true perpendicular instead of at right angles to the shaft of the tibia. Shifting of the heel-pad and so-called spurs in Syme amputations is merely

a result of inaccurate judging of the angle of weight-bearing.

Prostheses have now been developed for Syme stumps which should overrule most of the objections to this type of amputation. (Fig. 12.) This lightweight, laminated plastic prosthesis, developed by the U. S. Naval Hospital at Mare Island, California, is lined with the new unicellular sponge rubber and has complete ankle motion, including dorsi and plantar flexion, eversion and inversion.

*Amputations below the Knee.* It is universally accepted that the best amputation for anything below the knee is in the mid-calf region 5 to 7 inches distal to the plateau of the tibia. This stump can be fitted with the standard type of prosthesis that is so simple that repairs can be made in any local hardware or blacksmith shop. Variations in the prosthesis such as padded sockets, slip-sockets or absence of the thigh lacer may be supplied to selected cases.

Short stumps below the knee often present problems in surgical technic and fitting. It is usually advisable to remove the entire fibula in any stump of 3 inches or less. The interosseous membrane between the tibia and fibula is absent above this level to allow passage for the anterior tibial and peroneal vessels. If the fibula is left in place, the pull of the tendon of the biceps femoris is sufficient to rotate and abduct the fibular stump externally to such a degree that fitting with proper weight-bearing areas is impossible.

A difficulty in fitting short below-knee stumps is the lack of sufficient length so that the stump will remain in the socket. The hamstring tendons of the thigh have a comparatively low insertion on the tibia and fibula, respectively, and may be cut away, reinserted at a higher point or allowed to retract. The motion of active extension is certainly the most important in walking and locking the knee joint. Gravity, the weight of the prosthesis plus the flexor action of the gastrocnemius muscles provide sufficient motion so that walking is carried out normally.

If because of injury to the knee joint surfaces weight-bearing on the joint is undesirable and yet knee motion is possible, prostheses have been devised whereby weight-bearing is placed on the ischial tuberosity through a rigid thigh-piece. Normal knee motion is thus maintained with the tibial stump as the motor for the

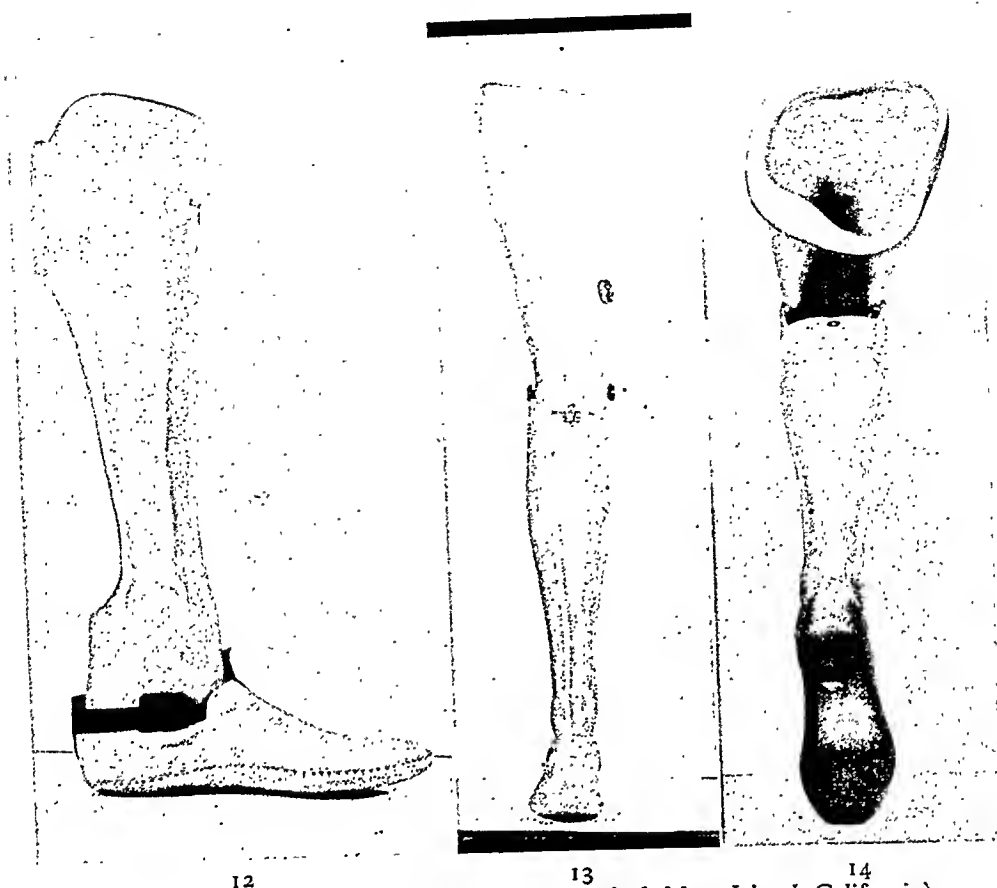


FIG. 12. Syme prosthesis (courtesy U. S. Naval Hospital, Mare Island, California).  
 FIG. 13. Suction socket above knee prosthesis (courtesy U. S. Naval Hospital, Mare Island, California).  
 FIG. 14. End view of thigh piece, suction socket.

prosthesis below the knee, without weight-bearing on the injured joint. Platform prostheses with a free-swinging shank have been made for short, flexed below-knee stumps in such a manner that weight is borne on the bent knee.

*Amputations above the Knee.* In any amputation above the knee the problem of maintaining the prosthesis on the stump is of prime importance. The standard methods of attachment, such as the heavy articulated pelvic belt or the shoulder harness, are cumbersome and not entirely satisfactory. Variations in the type of stump will sometimes allow fitting of appliances which are quite stable without these disadvantages.

Knee disarticulations, with or without the removal of the patella, present a stump with sufficient bulbous flare in the femoral condyles that a molded leather lacer corset may be constructed to fit tightly enough that no other suspension support is necessary to keep the artificial limb in place. As a result of the find-

ings of the Army Surgeon Generals' European Commission on Amputations and Artificial Limbs, the "suction-socket" prosthesis is rapidly gaining in favor in this country. Figures 13 and 14 illustrate this principle in an above-knee prosthesis. A more fleshy stump with active motion in the thigh muscles is desirable for this type of appliance, as direct contact between the skin and the socket is required for complete sealing and maintenance of sufficient negative pressure to hold the limb on the stump.

End-bearing stumps, such as the Gritti-Stokes', tendoplastic or Callander type amputations are done according to the likes or dislikes of the surgeon. The most important technical point is the angle of the weight-bearing surface as in the Syme amputation. The shaft of the femur is not perpendicular to the weight-bearing surface and the saw-line should not be at right angles to the shaft of the femur. No radical changes have been made in appliances for these amputations.



FIG. 15. Anterior view, tilting-table prosthesis.

The stump of amputations above the supracondylar, Gritti-Stokes levels should not be longer than 3 inches above the knee joint. Anything longer than this level not intended for weight-bearing makes it necessary to extend the thigh piece to include the artificial knee joint, shortening the shank and thus placing the artificial knee joint lower than the normal joint. The average femur measures 17 inches from the greater trochanter to the knee joint. Length beyond 12 inches is considered superfluous in any non-weight-bearing stump above the knee.

Improvements have been made in prostheses for amputations above knee stumps as short as 2 inches measured from the crotch. Thinner stumps are preferable. The anterior surface of the thigh piece is built high into the groin to prevent the stump from slipping out of the socket but the leg is quite uncomfortable in a sitting position.

When possible the head, neck and greater trochanter of the femur should be left in place

to conserve the normal contour of the buttock and the pelvis. If the femur stump is too short to be of use as a motor mechanism, a tilting table prosthesis may be applied. (Fig. 15.)

#### SUMMARY

Anyone who had the opportunity to serve in a military amputation center during the past war would be impressed by the lack of adequate coordination in civil life between the surgeon, the physiotherapist and the limb fitter. Usually the surgeon performs the amputation and with the healing of the operative scar considers his job done. From that time on it is the responsibility of the patient, with instruction from no one, to condition and shrink the stump in preparation for fitting. The patient is left to his own devices to search out a limb fitter who, depending on the equipment in his shop, will supply the type of artificial limb which is the most profitable for him to make. Upon receiving his prosthesis the patient again has nothing but hearsay and perhaps the advice of a neighboring amputee to rely upon for instruction in the use of his prosthesis.

Every surgeon doing amputations should have at least some idea of the problems which confront the amputee. It is surprising how few people know even the fundamentals of using crutches properly. Physiotherapy with special exercises to re-develop the muscles to be used in the function of the artificial limb is extremely important. It is not difficult to understand that these muscles should be even stronger than those in use in the normal limb.

The shape and length of the stump and its application to the most desirable prosthesis should be of prime importance at the time of amputation. The surgeon should be well acquainted with recent developments in artificial appliances and their fitting to provide the patient with as nearly perfect a combination as possible.

#### DISCUSSION

J. DEWEY BISGARD (Omaha, Neb.): I asked Dr. Swenson, who has been associated with me in practice, to present this material for two reasons: First, he served for over two years in an amputation center and during his period of service gained a very unusual experience and can speak with considerable authority. Secondly, I believe, as he has stressed, that in civilian life the postoperative management of amputees, namely, the proper fitting, management and education in the use of



prostheses, is dealt with very inadequately. I think most of us through lack of knowledge, experience or interest delegate this important responsibility to a layman who has no background of physiology or anatomy necessary for the proper use of these prosthetic devices.

I have seen Dr. Swenson work with a few amputees who have been so handled, and by some simple alterations in the prosthetic devices or even a little education in how to swing the leg he has improved their function and made them far more comfortable. For example, I have seen him show people how to walk upstairs as one would normally rather than go up one foot at a time sideways.

I was glad to hear Dr. Swenson stress the conservation of as much of the extremity as possible. Now that we have antibiotics, improved methods, newer vasodilatory drugs and chemical and surgical sympathectomies, the old dictum of amputations above the knee in peripheral vascular disease no longer holds and is no longer good surgery in some cases.

I have a few cases (as many of you have) who have had transmetatarsal amputations for diabetic gangrene of the toes, have gone ahead and healed primarily without any difficulty and have been spared the necessity of getting a prosthetic device for many months or years.

AUGUSTUS THORNDIKE (Boston, Mass.): Your new President, Dr. Magnuson, has inveigled me into taking on a job with him concerning the research into newer prosthetic developments. Although there is little to report at this meeting, I believe that within twelve months we will be able to give you some proven information. It is only fair to say that these new developments are still on field test. I will go over a few of them if you understand that I am not saying they are perfected.

As Dr. Swenson says, it is important that we surgeons become acquainted with the fitting and training of our patients in the use of these prostheses. We must see our patients through the entire process. I think our Army program in our amputee centers is the first of its kind whereby we really developed a training procedure for the arm amputees so that in a week's time the patient could go out with his prosthesis and within six or eight weeks the leg amputee had even learned how to dance. We found that the use of music, as far as part of the leg amputee's training was concerned, developed a rhythm in his gait that he could not attain until he learned to dance. His balance and his rhythm were developed with the aid of a record player and a dancing partner.

The lower extremity suction socket you have seen. Within two months it will be on 800 wearers and we believe that is a sufficient group to give it a good field test. It is not ideal for all above-knee amputees, but a large majority of them who have worn them up to now claim that for the first time

they feel as if their prosthesis were part of themselves. I have seen the suction socket on one above-elbow amputee and he particularly was pleased that it belonged to his body and no longer was hanging loose.

One of the major problems in the upper extremity prosthesis is that it pulls away from the stump and the patient feels it does not belong to him. If we can develop a suction socket there, I am sure we will get a more utilitarian prosthesis.

There are two types of hydraulic knees now under test, the Catranis hydraulic utility leg which will fit into any standard leg and be inserted into any artificial limb made. It weighs approximately 1½ pounds and depends upon a pressure pad against the rectus-femoris and sartorius attachment for its mechanism function. Together with the suction socket we have thirteen such cases on field test today.

The Northrup Vane type hydraulic knee works on a release mechanism that depends upon heel contact with the ground. To my mind this is not as smoothly a functioning development as the Catranis knee at the moment.

The Mare Island naval program has developed a soft socket for below-knee amputees. I believe this is a good development.

In the upper extremity there is a great question as to how valuable cineplastic procedures are going to be. I have seen tunnels in triceps, biceps, the pectorals and the pilot wearers who are developing this for us. All believe that unless the muscle tunnel is built on the anterior surface where they can keep it clean and see it themselves (the triceps they cannot clean and are not happy about that location), will not be able to care for it properly.

Many of us were acquainted with the cineplastic work done by Dr. Sauerbruch with his arm after the last war, and I often wonder what has happened to it. I believe that a person will wear one of those for so many years and then they give up the use of the tunnels after awhile. The muscle motors, of course, in those tunnels are very limited in the amount of movement they will produce in any transmitted wire to a hand or hook.

New elbows that are being developed are the Hosmer and Northrup elbows. All of these devices add weight to the upper extremity and pull it away from the stump. I do not think we have the ideal elbow for the above-elbow amputee.

A new pronator and supinator mechanism that you saw demonstrated in the slide of Northrup, and another one by Hosmer, are good for below-elbow amputees. That is a definite advance and I believe the "bugs" are out of those two devices. The Northrup is very much lighter in weight than the Hosmer.

Work is being done at the Army Prosthetics Research Laboratory at Walter Reed General Hospital on a positive action hook. Many of you



know the Dorrance hook, which is negative action and depends upon its gripping power on an elastic rubber band to hold the claws together. There is no control of the squeeze action of the Dorrance hook. The hook developed by the Army, on the other hand, will operate with positive control action from the opposite shoulder loop.

The miracle hand which has been described weighs 18 ounces. It is too heavy and too cumbersome, and I know very few amputees who, after they have it, want to wear it.

The cosmetic hand or glove with the Northrup pronator and supinator apparatus is a development that is going along very well. It is a synthetic rubber-like material which is stretched over an artificial hand or finger or part of a hand, and gives the appearance and color match, wrinkles and hair of a normal hand. I think it is going to be most

useful in the partial amputation of the hand, that is, of the thumb and some of the fingers.

S. A. SWENSON (closing): We still need a great deal of coordination and cooperation between the surgeon, the physiotherapist and the limb fitter. After the amputee has received his prosthesis there should be some facility by which he can be instructed in its use. All of these special services for the amputee could be consolidated in civilian amputation centers distributed over the nation. There would no doubt be considerable opposition from all quarters but certainly the problem continues to grow. If such interest in the welfare of the amputee is continued, amputation centers will be established, whether under control of private interests or governmental agencies, and will provide more adequate rehabilitation of any individual who has had the misfortune to lose an extremity.



# END RESULTS OF CERTAIN PROCEDURES IN THE SURGERY OF TRAUMA

WILMER C. SMITH, M.D.

*Salem, Oregon*

**O**BSERVATIONS and accumulated experience arising from association with disability evaluation should contain something of value to the individual actively engaged in the practice of surgery, especially that surgery which concerns itself with the treatment of trauma. These observations are based upon a period of more than ten years of familiarity with disability awards as given by the Oregon State Industrial Accident Commission.

It is entirely proper that one should ask at the outset what validity conclusions so arrived at may carry and, therefore, what attention they actually warrant. There are three general considerations which should be presented in answering this. In the first place the number of cases handled by this organization is quite large, approaching some 50,000 claims per year and, hence, the number of examples of any particular condition or of any special type of treatment is greater than that seen by almost any single physician. Secondly when treatment has been concluded and the condition has reached a stationary state, these patients are seen by medical examiners who are especially familiar with the recognition and evaluation of disability; this is estimated on a numerical basis. I believe that there are two advantages in such a method. In the first place the individual who estimates the end result is not the physician who treated the patient. This eliminates the pardonable pride in his end results which might influence the evaluation of the treating physician to some extent. In the second place, although it is open to error, a numerical evaluation in terms of percentage loss of function is in general more definitely expressive than is a rating based upon good, fair or poor, this latter method or some variation is often used by physicians in reporting their end results. Lastly, I think it is a fact that a more thorough follow-up system obtains in these cases. It is often true that the original treating physician loses sight of patients who believe after a certain period of treatment or num-

ber of calls that little more is to be gained by further consultation. However, in our cases the patients hope that further treatment will result in more complete physical restoration or that as a result of aggravation disability evaluation will be revised; this tends to bring them back years after the last call to the original treating physician. As a matter of fact as long as there is any dissatisfaction with the results of treatment or whenever aggravation appears, these patients invariably "come home to roost"; and although those of us connected with this type of work often wish it otherwise, the fact remains that our follow-up is most complete. It may, therefore, be said that observations made in this field recommend themselves to the consideration of the practicing surgeon by virtue of multiplicity of example, impartial, definitive evaluation and thoroughness of follow-up.

I am, of course, aware of certain arguments which are often advanced tending to impeach the value of conclusions based upon compensation experience. The most common is that the patient fully realizes he is "before the cashier's window," and that every possible complaint or objection to his end result will be elaborated upon for the obvious reason that he believes his financial return will be based largely thereon. While this criticism is true in many instances, it is also a fact that a great number of these patients do not engage in more than the usual amount of complaining common to humanity in general. It should also be noted in this connection that examiners familiar with problems of disability evaluation are more than usually astute in discounting complaints without reasonable basis. Still another fact which obtains in patients covered by an Industrial Accident Commission which is not generally appreciated is the fact that these individuals as a rule are engaged in active physical labor and, therefore, surgical procedures performed upon them are generally subject to greater strain than the same surgical procedure would be in the patient whose occupation is largely sedentary. For example, in the case of a spinal

fusion the average private patient who is willing to suffer the consequent time loss and is able to finance the surgery and the subsequent inactivity is in general not an individual who, by reason of his occupation, is forced to put great stress upon the lower back. More often, indeed, he is a desk worker and for this reason his spinal fusion will never be subjected to the crucial tests that come with the daily lifting and carrying of heavy weights so common among industrial workers. I, therefore, submit that procedures in the surgery of trauma are given a more severe trial in the case of the industrial worker who comes under an Accident Commission than in the instance of the average private patient and it is not unfair to state that, perhaps to some degree at least, the objection connected with "the cashier's window" is met or even completely balanced by the fact that the industrial worker subjects his surgery to a more rigorous test than does the private patient.

#### SPINAL FUSION

It has been our observation that in certain selected cases spinal fusion is indicated and in these cases its results are generally very good. At the same time it has been evident that in a larger group of patients in whom spinal fusion was resorted to solely because all other forms of therapy were unavailing, the results were appallingly bad. In our experience the greatest benefit from spinal fusion is found in those patients below the age of forty and preferably less than thirty who have a past history of frequent back injuries resulting from minor trauma and who upon examination reveal well localized pain and tenderness and especially whose x-ray examination reveals architectural defects limited to the area of complaint. Even in these cases fusion should not be resorted to until an adequate period of conservative treatment has been tried or unless the periods of disability from minor back injuries have become sufficiently frequent to warrant more radical treatment even though the present attack might respond to conservative therapy. Our results have not been so encouraging in patients above the age of forty, even though the patient may otherwise qualify; in like manner the patient whose pain and tenderness is diffuse and not localized sharply does not appear to be nearly so good a candidate for fusion as does the individual who presents a relatively sharp

localization of complaints. As to the architectural defects which lend weight to the indications for fusion, the most common are those of congenital or developmental origin. These usually consist of gross asymmetry of lumbosacral articulating processes. This asymmetry may be either in size of the respective processes or in the plane of their articulations.

The architectural defect prompting fusion should be of such nature that it can be obliterated by a fusion which includes the fewest possible vertebrae. We have noted almost uniformly that the greater the number of vertebrae fused the higher is the disability, and the more frequent are complications such as pain or pseudo-arthritis. It is really doubtful whether the results ever warrant a fusion involving more than three vertebrae. Our experience with fusions done in the hope of alleviating symptoms resulting from an uncorrected compression fracture deformity of a vertebral-body have been most unsatisfactory and it is my observation that the operation is not justified in these cases.

The presence of any significant degree of arthritis, either osteo-arthritis or rheumatoid arthritis, has been one of the important contra-indications to fusions, even though the case may otherwise meet the requirements satisfactorily. If arthritis exists to any important degree, I am extremely doubtful that fusion will prove worth-while. We have found in these cases that disability after fusion is actually greater than that which existed before. It would seem reasonable to explain this by the generally accepted fact that arthritis involves numerous articulations and is seldom limited to only one set. Moreover, it is commonly observed that an arthritic joint tolerates any forceable increase in its range of motion very poorly; such a joint which is otherwise relatively symptomless may be quickly flared into acute activity by increased stress and strain. Thus it may well be that when certain articulations are deprived of motion by spinal fusion, the contiguous articulations are subjected to a greater range of motion and, consequently, a strain to which they are unaccustomed. Like any other arthritic joint subjected to the same stimulus, they respond by acute inflammatory reactions. The frequency with which the pain and tenderness ascends to the region of the upper end of the fusion mass in these arthritic patients seems to lend considerable support to

this assumption. I have seen cases in which, to combat the pain in its new location, another vertebra was subsequently included in the fusion with the result that the complaints promptly rose one segment higher. One wonders in these cases just how far up the spinal column the source of discomfort could be pursued if both patient and surgeon were willing to continue fusions indefinitely.

Along with the arthritic patient another type of case in which our experience shows fusion to be of no value is the patient in whom there is no indication for fusion except failure of other forms of therapy. The classic example is the individual who may or may not be within the age group mentioned who usually has no history of former back injuries or if former injuries were suffered, these have been widely separated in time and have been the result of adequate trauma. Examination reveals a very poor localization of pain which may involve most of the lumbar area or may be entirely over the sacrum or sacroiliac articulations. Tenderness, also is apparently diffused rather than localized, or if localized, fails to correspond with spinal articulations, often being over the dorsum of the sacrum or in the sacrospinalis muscle mass lateral to the lumbar articulations. X-ray examination fails to reveal any structural abnormalities or, at most, a narrowing of the intervertebral space between the fifth lumbar and first sacral vertebrae. Here one is confronted with a patient who presents none of the indications for fusion and is recommended only by the fact that all other forms of therapy have failed. The results of fusion in this type of case have been uniformly without benefit or even disastrous. When examined for closure about twelve months postoperatively, the patient will state that surgery resulted in no improvement and that if he had it to do over again knowing what he now knows, he would not submit to the operation. There is a sizeable group of these patients who will assert that they have been made decidedly worse as a result of the operation. Careful examination will disclose that a certain percentage are grossly exaggerating; however, in some instances examination will convince the impartial examiner that a considerable number are actually justified in this complaint. These patients will show greater limitation of motion, increased muscle spasm and other evidence of acute discomfort. One is convinced that they

are actually considerably worse off than they were before spinal fusion, some of them being permanently and totally disabled while their disability may have been only half this extent before surgery. I am totally unable to explain what has happened in these patients. The most painstaking x-ray examination may fail to reveal any evidence of pseudoarthrosis or other defects of fusion. I am, however, convinced of the reality of these occasional unfortunate results. In any large number of patients in which fusion has been done without real indications other than persistent back pain, our follow-up demonstrates most convincingly that the majority will be unimproved while a very definite and important minority will have been made decidedly worse off as a result of the surgery.

#### DISC SURGERY

Our experience with partial hemilaminectomy for protruded intervertebral disc has on the whole been very satisfactory. In cases in which an actual protrusion of the disc was demonstrable and in which the symptoms and findings corresponded to what might be expected from root irritation at this point, removal of the offending protrusion has resulted uniformly in a relatively short period of convalescence and in comparatively low permanent disability. In view of the fact that the symptoms and signs which underlie the diagnosis of herniated discs are largely of a neurologic nature, we have made it a policy to restrict this operation to the neurosurgic field. An orthopedist does the fusion in instances in which this additional procedure is carried out. I believe that it is desirable to carry out contrast myelography for the purpose of demonstrating the protruded disc before surgery is decided upon. I am aware that it is not always possible thus to demonstrate the protrusion; however, these instances are relatively infrequent and the added assurance gained in those cases in which protruding discs are demonstrated is well worth the time and trouble required by the procedure. For some time the contrast medium used was lipiodol. This was removed with great difficulty and in time often proved very definitely irritating. Since the advent of pantopaque we have had no indications of any irritative phenomena and it has been uniformly possible to remove almost all the contrast medium at the completion of the

study. We do not believe that exploration without previous demonstration of the presence of a disc is indicated unless the symptoms and findings are extremely typical.

#### THE COMBINED OPERATION

For the past few years I have been deeply interested in the combined operation consisting of hemilaminectomy with removal of the disc herniation and at the same time spinal fusion carried out by an orthopedist. I realize that there are many who routinely advise that fusion be done in all cases in which disc surgery has been performed. My own observations do not substantiate this view. A study of our records reveals that in cases in which the combined operation has been carried out permanent disability averages 40 per cent greater than in cases in which hemilaminectomy alone has been done. The same study reveals that instances of recurrence of disc herniation have been infinitesimal.

The reasons usually given for the combined operation are first, the possibility of recurrence; secondly, the fact that an injury to a disc may be expected to change the intervertebral space and thus change the relationships of the articular facets resulting in some pain from this source.

Recurrences in our experience have been so rare as to warrant no consideration and whatever may be the virtue of the theoretic point concerning altered relationship of the articular processes, the fact still remains that permanent disability resulting from hemilaminectomy alone is increased by 40 per cent in those cases in which fusion is done. Those cases of old compression fracture of a vertebral body which, as already stated, are not benefited by spinal fusion comprise another potent objection to the theory of altered relations between articular processes resulting from disc injury constituting an indication for fusion. In these cases the compression of the vertebral body by allowing the body above to approach the body below the fracture alters the relationship between the inferior articulating processes of the vertebra above with the superior articulating processes of the fractured vertebra far more than does any nucleus pulposus herniation.

There is no reason to believe that the usual results of spinal fusion will be in any way altered by the fact that a protruded disc

has been removed. In other words in all cases other than those which present indications for fusion as heretofore described there will be two groups; first, the large group of patients who have gotten no benefit from operation; and secondly, the smaller group who are definitely made worse by spinal fusion. Thus it can and does happen that an otherwise successful operation upon a disc can be completely changed into a dismal failure by the addition of an unsuccessful spinal fusion.

#### CASE REPORT

On July 10, 1946, J. G., a male, thirty-four years of age, suffered a severe lifting injury of his lower back. Pain forced him to stop work at once and consult his family physician who for a period of some two months carried out conservative treatment. As a result of marked right leg radiation and when no improvement was seen on conservative regimen, a herniated disc was suspected. Accordingly, the patient was referred to a neurosurgeon whose findings were sufficiently definite to convince him that right-sided disc protrusion actually existed. Since this man had to do heavy work, the neurosurgeon thought that fusion should be carried out at the time of the disc surgery and referred the patient to an orthopedist who upon x-ray examination discerned some narrowing posteriorly of the intervertebral disc between the fifth lumbar and first sacral vertebrae. It was his opinion that an unstable lumbosacral junction was present and he agreed that fusion should be done in addition to disc surgery.

The combined operation was carried out on November 5, 1946. A herniated nucleus pulposus was disclosed on the right side of the disc between L4 and L5. This was removed and followed by a fusion L4 to S1. The orthopedist provided the postoperative follow-up, and in a report dated January 19, 1948, indicated that the patient's condition was stationary and the claim ready for termination.

On February 20, 1948, the patient was examined by one of the regular examiners of the Oregon Accident Commission. The patient complained of marked pain and tenderness at the upper end of the fusion mass. There was extensive muscle spasm and abundant confirmatory evidence that complaints were well founded. Leg radiation had remained absent since the completion of surgery but back complaints were so severe that the examiner reported the patient as being, in his opinion, totally disabled. The patient was referred again to the orthopedist. After assuring himself that the present fusion was sound and no further pathological condition had developed, he suggested that another vertebra be added to the fusion in the hope of controlling the obvious pain and disability.

This additional surgery was authorized; and although the outcome is not yet evident, I fear the chances are better than not that no worth while improvement will be obtained.

I believe the great McBurney is reported to have said "God deliver me from a surgeon of but one case." Although this is admittedly an extreme case, I have, nevertheless, seen enough variance of this result to convince me that such an outcome or some degree thereof is not uncommon. While one, of course, cannot say with certainty, I believe the preponderance of evidence indicates that disc surgery alone might have been quite successful but the addition of a fusion was disastrous.

We, therefore, are forced to conclude on the present showing of our records that the additional benefit to be expected from the combined operation is far out-weighted by the increased disability consequent upon it, to say nothing of the greatly lengthened convalescence resulting from the fusion.

While I do not believe that the combined operation should be done routinely in all disc cases, I do believe that our results clearly demonstrate that in those who present indications for spinal fusion there should be no hesitancy in carrying out the combined operation. That is to say, if the findings are of such a nature as to indicate fusion, the fact that a protruded disc exists and is removed at the same time in no way alters the need for spinal fusion.

I would, therefore, sum up our impressions by saying that, in general, operations for removal of a protruded intervertebral disc have proven quite satisfactory. It is our opinion that the removal of an intervertebral disc herniation is not, in itself, an indication for spinal fusion. We believe spinal fusion should not be done unless the indications for this operation are present and exist independent of the disc injury. I believe it is better to perform only a hemilaminectomy in those cases in which spinal fusion is not clearly indicated and, if necessary, to perform spinal fusion later rather than subjecting the whole group to the combined operation with its inevitable 40 per cent increase in permanent disability and its occasional disastrously poor outcome.

#### DISCUSSION

ALEXANDER P. AITKEN (Boston, Mass.): Two years ago I presented before this Society a paper November, 1948

on a similar subject, the end results of ruptured intervertebral disc in industry. Since the publication of that paper I have not been too popular with certain individuals in certain sections of the country. To evaluate any operation we must have a complete end result study. Dr. Smith's opinions are based upon long experience and a complete follow-up of these cases.

This past February, before the American Academy of Orthopedic Surgeons, a paper was presented on the end results of ruptured intervertebral disc by an author who reported that he had operated on 160 patients although his end results were based upon the actual analysis of ninety cases. These ninety cases were either re-examined or answered questionnaires sent to them. As a result, he came to the conclusion that 86 per cent of his cases had excellent results. Seventy patients who did not answer his questionnaire and did not return for examination were simply forgotten. It seems to me that some of these seventy patients were not entirely satisfied with their end results and that may explain why they failed to return for examination or to answer the questionnaires.

I think the opinions expressed by Dr. Smith are important in that his opinions are based upon true end result studies.

In Dr. Smith's experience the end results of the ruptured intervertebral disc were excellent. This is unquestionably true. However, in Oregon he is able to control a good deal of the surgery that is performed; he is able to see that these patients are placed in the hands of conservative and competent men.

However, no such situation exists throughout the country. In states where we have free choice we still see rather promiscuous disc and back surgery being done. The end results throughout the country of this type of surgery are still very poor.

I think in the treatment of low back injuries we have got to develop some common sense program before we can obtain universally good results. It is my belief that the ruptured disc does not occur spontaneously. I do not believe a normal disc will rupture; before any disc can rupture, I believe it must first degenerate. That degeneration takes place over a long period of time and is the end result of instability in the low back. Therefore, I believe that in the treatment of this lesion not only is it essential to remove the offending disc but it is also essential to remedy the instability in the low back.

It may seem that I am taking issue with Dr. Smith. Actually, I am doing no such thing. I agree with everything he has had to say. I believe before any patient is subjected to disc surgery he should be examined not only by a neurosurgeon but also by an orthopedist; and it should be determined before any operation is performed whether or not

that patient has an unstable type of back and whether spine fusion is indicated.

If a patient gives a long history of back pain and the x-rays show definite asymmetry in the facets, as pointed out by Dr. Smith, and if that individual then develops leg pain as a result of rupture of a disc, I believe simple removal of the ruptured disc may relieve that patient's leg pain but it has done nothing for the disability caused by his unstable back.

I believe that type of back should be fused. I, therefore, am in favor of the combined operation. I believe if a patient has no abnormalities in his low back, if he is a young individual and does not have a long history of back pain, his symptoms could then be entirely due to a ruptured disc and I would agree that simple removal of the disc would effect a cure. However, if the patient has instability in the low back and has a long history of back pain, I believe the combined operation should be performed.

The end results of spine fusions as seen in industrial cases are unquestionably poor. This is due largely to poor technic. However, in our experience, if patients are carefully studied and the cause of instability determined, and if a careful fusion is performed followed by an adequate period of bed rest and immobilization, good results can be obtained. Such patients can then return to occupations of a relatively heavy nature. The poor results of fusion are usually due to poor selection of patients, poor technic and after-care.

JOHN E. RAAF (Portland, Ore.): I agree with Dr. Smith that in a majority of instances a patient who is suspected of having a protruded intervertebral disc should have a pantopaque myelogram. I am sorry I did not know Dr. Smith was planning to talk on this particular subject, otherwise I would have refreshed my memory on some of our figures. Earlier this year we reviewed our disc cases and, if I remember correctly, our pantopaque myelograms were approximately 76 per cent accurate in localizing intervertebral discs.

Our clinical impressions before the pantopaque studies were done were about 80 per cent accurate. We believe, therefore, that if we supplement our clinical impression with information gained from the pantopaque study, we are in a

better position to arrive at an accurate diagnosis than when we rely on our clinical opinion alone.

The problem of whether to limit the operation to removal of the protruded intervertebral disc or to remove the protruded intervertebral disc and then do a spinal fusion is a difficult question to answer.

Spinal fusion was done in approximately 37 per cent of our 224 patients. Perhaps that figure is too high. Dr. Smith mentioned that by fusing the disability in disc patients is increased 40 per cent. I know from our studies that the time loss was increased. I also know that the various agencies, such as the State Industrial Accident Commission who are paying the workman's compensation are out more money when a fusion is done. I believe word has been passed around among workmen that if a fusion is done the patient automatically deserves a bigger disability award than if a protruded intervertebral disc is removed and no fusion done. The fact that a fusion has been done indicates to the workman that the back is in very bad condition as a result of the injury.

In the study of our cases we found we had obtained 60 per cent excellent results, approximately 30 per cent good results and 10 per cent poor results. By excellent results I mean those patients were able to go back to their original occupations or occupations equally as arduous. Good results means that those patients were able to work but were limited in the amount of work they could do. In other words they could not carry on the heavy type of work they did originally.

WILMER C. SMITH (closing): I am aware of the fact that when disc surgery was first begun the disc alone was done without fusion, and it is true that over the years the balance of opinion has swung largely toward the combined operation. However, I wonder if this is not the result of many of those cases with architectural defects or long periods of back trouble, coming from little or no trauma, which gave a poor result upon disc surgery alone and later had to be fused.

It seems to me that the pendulum has now swung too far the other way and that ultimately it will come to rest at a point where about one-third of the disc cases will have the combined operation done and the other two-thirds will be subjected to hemilaminectomy only.





# MANAGEMENT OF COMPOUND FACIAL INJURIES\*

JAMES BARRETT BROWN, M.D. AND MINOT P. FRYER, M.D.

*St. Louis, Missouri*

THE story of care of a patient with a severe facial injury is a long one, both because it extends from the time of his accident until his return to gainful employment and since it is a description of close attention to surgical detail. A summary of previously emphasized material will be given.

It is to be assumed that a careful, complete physical and neurologic examination is done and an estimate of the patients general condition made. If there has been a period of unconsciousness, there has been brain damage and x-rays should be made. In very severe injuries x-rays should be taken of the cervical spine since fractures occur here following snap blows of the head. Furthermore, aside from making the patient as comfortable as possible, providing an airway, and controlling hemorrhage, no extensive facial repair should be attempted until the cerebral condition permits it.

The majority of severe facial injuries result from a missile striking the face or contact with a relatively immovable object. Cause of the trauma is mentioned since this is usually an invaluable aid in diagnosis of the type and extent of the injury. These usually result in a compound facial injury, that is, involvement of both the soft tissue and underlying bony framework, and it is impossible to separate the repair of the one from the other. The term, compound, is also used to indicate injuries which involve loss of function of eyelids, nose, seventh nerve and mouth. Possibly a better term would be "complicated" or "severe," but usage has made it applicable to extensive injuries whether fractures are of great importance or not.

The primary repair should be done as soon as the patient's general condition permits, and in the first twenty hours if possible, before swelling, organization of clots and infection have occurred. If seen after this initial period and there is the necessity of manipulation through contaminated clots and edematous tissue, it is sometimes better to just approxi-

mate the soft parts and await the subsidence of swelling before replacing the bone fragments. However, the replacement of bone fragments should rarely be delayed longer than seven to ten days because the fixation of small, comminuted chips after this time may make their accurate realignment impossible. Shock and neurologic damage may necessitate delay and an intoxicated patient should not have his jaws wired together.

In many of these patients nerve blocks, especially deep injections of the branches of the fifth nerve, are the most satisfactory for anesthesia. Occasionally field blocks or local infiltration suffice. These may or may not be combined with a basal anesthetic such as avertin. General anesthesia is to be avoided when possible but is often necessary, especially in children. When used, the endotracheal method is almost always employed although occasionally endopharyngeal insufflation is sufficient in very small children.

A complete analysis of the extent of the injury, made on the basis of examination, history and x-rays is usually done in the operating room, following which the procedure for repair is planned. Complete reliance for diagnosis cannot be placed on x-rays alone. Roentgenograms of the facial bones should be taken, however, even if they are apt to be somewhat disappointing due to the superimposition of shadows in this area. The heavier ridges of bone show quite well in the antral and vertico-submental positions, but there may be many comminutions of the maxilla, ethmoid, nasal and other thin bones that are entirely missed on the x-ray plate. For the lower jaw, complete views of both sides including both condyles should be taken because multiple fractures may be missed even at operation.

Cleaning of facial wounds is extremely important and should be done with soap and water followed by ether and saline irrigations so that local antiseptics are seldom necessary; anesthesia may have to be given before the cleaning is completed because of pain. Oil

\* From the Department of Surgery, Washington University School of Medicine, St. Louis, Mo.





FIG. 1. A and B, early evacuation and immediate operation; one single operation for complete repair. (Courtesy of *Ann. Surg.*, 126: 624, 1947.)

ground into the face should be scrubbed and dissolved out completely. Bits of glass from rear vision mirrors or from completely broken, shatterproof glass are especially apt to be overlooked; for this reason it is well, if possible, to find out whether or not any glass was broken at the time of the accident so that search may be made accordingly.

Débridement should be done very sparingly both of soft parts and bone. If the usual idea of wide excision of torn edges were applied, many parts of features would be needlessly sacrificed. In dealing with loose bone chips extreme conservatism should be adhered to, and it is probably better to leave in some bone fragments that might die rather than adopt the policy of removing all loose fragments and thereby possibly discard many good supporting fragments that might live.

Before suturing the soft parts, additional cleaning can be done and fresh instruments used if the mouth secretions can now be avoided. Surface key sutures may be used for the known points. These may have to be deep but should never be wide, as wide suture marks can never be completely obliterated. Buried No. 000 white silk sutures should be used between these to approximate completely all wound edges unless the skin edges are so thin that these cannot be put in. The remaining surface sutures are then placed not more than 1 or 2 mm. from the wound edges to obtain

the final fine adjustment. No. 000 black silk usually suffices and may be removed in one to four days. Stay sutures may be put in from the inside of the cheek or nose. If these sutures are needed on the outside, they should always be tied over a gauze pad to prevent cutting across the wound and leaving permanent scars.

In complicated tears a correct replacement may be difficult, but a start is made at some known point such as the nostril border or the edge of an eyebrow. If none can be figured out, closure may be started in the center of the wound and the remaining areas bisected successfully until complete closure is obtained. If the final adjustment is not satisfactory, one should not be reticent about opening the wound completely and resuturing it. Triangular or trap-door flaps should be adjusted with particular care to avoid late deformity, especially about the lids, nose and mouth.

Small drains may be placed advantageously, ordinary rubber bands sufficing for small wounds. If the immediate covering of the wound is of fine mesh grease gauze, it may be removed later with minimal trauma to the wound edges and sutures. A firm pressure dressing of mechanic's waste should be applied overall to minimize hemorrhage and swelling and, thereby, infection.

Pressure dressings on the face, especially in fresh injuries, are as important as any place in the body. The use of fine, white cotton me-

chanics waste—now supplied as surgical waste—supplies an excellent medium of pressure, the final pressure, of course, being obtained with appropriate rolls of bandage. It is interesting that the first use of a pressure dressing recorded is in hieroglyphics and is in relation to facial wounds. The dressing should be regarded as a part of the operation and should be carried out with the same meticulous attention to detail.

The patient in Figure 1 represents a predominately soft tissue injury with almost no structure in the area left undamaged. By prompt surgical repair, without débridement or packing the wound open, this patient had her complete result obtained in one single operation.

Transverse facial fractures occur usually from heavy blows dispersed over the face. There may be a level of separation at the frontal zygomatic suture line and at the glabella on both sides; there may be one through the wall of the antrum that may extend all the way around and involve the pterygoid region; and frequently there is a complete separation entirely around just above the dental arch. The whole face may sag down and become noticeably elongated, and the dental arch may be completely loose to the patient's own sensation and on moving it with examining fingers.

Nasal, septal and palate fractures frequently occur along with the above separation and these small thin bones may be comminuted into multiple pieces. The nasal structure including the cartilages may be completely crumbled, and there may be one or more complete lacerations through the palate caused by the disrupted bone cutting through; the nasal passages may also be completely occluded. (Fig. 2.)

The zygomatic bone (malar or cheek bone) frequently receives the blow but is itself seldom broken. Instead, it is torn loose from its moorings at the frontal, zygomatic process of the temporal bone and the maxilla. The main displacement will be according to the direction of the force; if from the front, the zygomatic process will be crumpled back and broken by the zygoma itself; if from the side, the ascending ramus of the zygoma may be tipped in and impinge on the orbital space. In nearly all loosening of this bone the antral wall crumples; and if it should sag down too much, the orbit

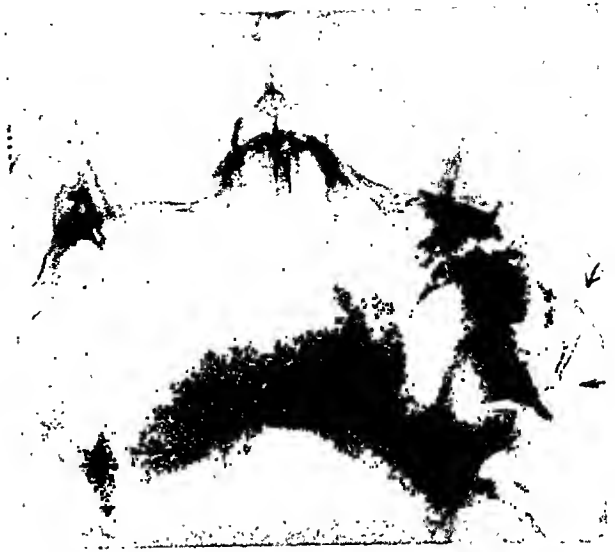


FIG. 2. Badly comminuted fractures of the facial bones separating and elongating the whole face. There is a crumbled zygomatic process on the right in addition to separation at the suture lines and depression of the orbital borders on both sides.

becomes elongated and the globe may descend so much that binocular vision is impaired. Blindness may result from section of the nerve by a loose, thin piece of bone and from intra-ocular or direct ocular damage. The extra-ocular muscles and nerves may also be torn. The lacrymal apparatus may be impinged on if the frontal process of the maxilla is driven in.

Inner canthus displacement occurs if the nose with the frontal processes of the maxilla is crushed backward, there being an actual chiseling open of the front of the face. This deformity is as important as any other in which early repair must be accomplished, because if left until fixation occurs, the canthi probably never will be sunken in normally again.

Nasal flatness goes along with the canthus displacement and the two are corrected together by withdrawing the depressed tissue and bones, molding them into their normal positions and frequently holding them there with through-and-through silver wire sutures inserted under the separated frontal processes and held on the outside of the nose over lead plates.

The general rule for repair is simply to replace these fragments and maintain them in position with the least manipulation possible. This replacement amounts to open reduction and access to the orbital border can be gained by a short incision in the buccal fornix, then into the antrum through the fracture line that



FIG. 3. A, depressed orbital border; B, orbital border elevated by going into the antrum through the fracture line and raising the fragment with an elevator, then holding it in place with an iodoform pack. Density in the antral region shown in (B) was due to the iodoform pack which was removed two weeks later, leaving fragments solidly fixed in good position.

is almost always present. The depressed border can then be elevated into position with a Kelly clamp. This bone may be locked in place; but if there is much comminution, the whole number of fragments including the anterior and lateral walls of the antrum may be "mulched" in position and held with an iodoform pack in the antrum, with the end left just through the opening in the fornix. (Fig. 3.)

When teeth are available, the simplest method of immobilizing a fractured mandible is with interdental wires. These are usually of 24 or 26 gauge stainless steel which are twisted around the teeth in correct occlusion, following reduction of the fracture. To gain further stability, as in symphysis fractures, a Risdon arch can be constructed by twisting a 24 gauge wire around the molars on both sides, posterior to the fracture, carrying these wires around the dental arch, anchoring them to the individual teeth with fine wires and twisting them together in front.

However, in some fractures of the lower jaw in which interdental wiring cannot be done, a wire of the Kirschner type drilled across the fracture line may be an easy and satisfactory method of treatment.

The indication for this internal fixation may be present when the opportune early time for

interdental fixation has passed and the fragments have become displaced, with compounding into the mouth, infection and local sloughing. It also may be considered in edentulous jaws, when there is much comminution and accompanying injury as in gunshot and war injuries when many teeth have been loosened or broken in displaced symphysis fractures and in fractures at the angle in which the posterior fragment is pulled out and up into the upper buccal fornix by the closing muscles. This last deformity is one of the worst to contend with and, if left uncorrected, may result in non-union of the fragments. It may also prove to be of value in certain separations of the upper jaw.

The internal wire will insure fixation in one plane, that is, the fragments cannot slip up or down past each other. However, they might rotate in or out or they might pull apart and, therefore, the addition of an anterior wire dental arch will give a second plane of fixation that will prevent rotation and will jam fragments in impaction so that separation will not occur. If there is also a condyle fracture to deal with or if normal occlusion cannot be maintained, there can be the further addition of interdental fixation to the upper jaw.

Multiple internal wires can be used for multiple fractures or to give the second plane of fixation if desirable.

## SUMMARY

In summary, an attempt has been made to correlate and re-emphasize principles of care of severe facial injuries, borrowing some material directly from previous publications.

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## DISCUSSION

MICHAEL MASON (Chicago, Ill.): I cannot, of course, do more than pay humble tribute to the work presented by Dr. Brown. The contribution made by him is not confined to the field of plastic surgery or to the surgery of trauma. His real contribution has been to point out certain principles of surgery. The field in which he has chosen to demonstrate these principles has been that of plastic surgery. One would be stupid indeed not to recognize that what he told us and the brilliant results he demonstrated are basic principles and their applications. One would be even more obtuse not to realize that these same principles apply to all of surgery whether dealing with injuries or disease. Most of these principles we have learned the hard way and they have been pieced together from many sources. The plastic surgeon and the surgeon dealing with trauma can feel proud because they have contributed much toward the establishment of these principles.

They are all very simple, almost self-evident axioms, yet it is surprising how difficult it is to pound them into the heads of medical students. It is easy to give lip service but it is equally easy to disregard these principles in actual practice. They are all based on the concept of surgery as an experiment in wound healing and this means an appreciation of living tissue.

Some of these principles are: (1) Early care not just because by so doing we reduce the period of time over which contamination can occur but also

because early care means early healing; (2) avoidance of secondary contamination not only because of local and general effects of infection, serious though they might be, but because we promote healing if we relieve the tissues of the need for combatting infection; (3) removal of devitalized tissues which not only helps to prevent infection but also relieves the healing tissues of the need of extruding or absorbing dead tissue; (4) restoration of normal tissue relations implies not only repair of divided or fractured structures but also restoration of the normal physiologic tissue pressure and nutritional conditions for the purpose of wound healing; and (5) avoidance of adding trauma in any fashion, mechanical or chemical, because these, too, interfere with tissue repair.

These principles apply to the extremities, abdomen and chest as well as to the face, to general surgery and all its specialties and to the large or small wound. For these reasons Dr. Brown's presentation of injuries to the face has fundamental significance for all of us.

TRUMAN GRAVES BLOCKER, JR. (Galveston, Tex.): It must be emphasized that the treatment of concomitant fractures and intracranial damage takes precedence over facial lacerations and bony displacements, but this does not mean that the latter should be neglected or hastily done in an amateurish or haphazard manner. It is extremely important that careful planning be carried out on those individuals who have tissue loss, keeping in mind that the individual is to be restored, first, functionally and, secondly, cosmetically; and this to be accomplished with as few operative procedures as is possible to get the final result.

During the war Dr. Brown, by appointment from the Surgeon General's office, organized and gathered around him sufficient young men trained in plastic surgery to treat and rehabilitate approximately 15,000 wounded soldiers in the various plastic centers in this country. As a consultant he was able to standardize more or less the methods for their most efficient care. Dr. Brown has made one of the greatest contributions to American Surgery. He devised and popularized thick split grafts; and now that everyone can cut one, they have been added to the armamentarium of every surgeon who is treating trauma.

DONALD M. GLOVER (Cleveland, Ohio): The conservation of tissue which Dr. Brown called attention to is most essential. Here as nowhere else in the body, except perhaps in the hand, the principles of débridement must be altered to fit the needs of the future appearance of the patient.

I would like to emphasize just two points that Dr. Brown brought out, one being the question of the type of shelving facial laceration, or what he called the trapdoor laceration, which we see so commonly in accident rooms everywhere, and which are attractively laid out so that they fit

together nicely and are usually sutured as they lie and almost always result in unpleasant hypertrophied scars. These wounds should always be excised to provide perpendicular margins which will permit perfect approximation.

One other point he made I should like to emphasize also; that is the terrific deformity resulting

from fractures of the maxilla involving the orbital floor. The triangular fragment that is so commonly displaced downward and rotated, if immediately replaced, gives an excellent result; whereas the results of delay are dropping of the eyeball, imperfect function and disfigurement which require many operations for correction.



# ELECTRIC BURNS OF THE HEAD AND ARM WITH RESIDUAL DAMAGE TO EYES AND BRAIN

JOHN PAUL NORTH, M.D.

McKinney, Texas

**E**LECTRIC trauma occurs frequently enough to merit consideration by the general surgeon. The case reported herein illustrates most of the more common complications of the passage of an electric current through the body. Many factors influence the severity of electrical effects upon the tissues. Even though voltage may be known, the actual quantity of current (amperage) cannot be calculated in a given case because of the wide range of the resistance offered by different body tissues under varying conditions. For example the resistance of dry skin is considered to be 5,000 ohms but this may be reduced to 300 ohms by the use of moist saline electrodes as employed in legal electrocutions. The destructive effect of a current is directly proportional to the electrical resistance of the traversed tissue. The current tends to seek paths of least resistance and passes most readily through blood or cerebrospinal fluid. In so doing, however, the walls of such channels offering greater resistance to the current are subject to correspondingly more severe damage. In consequence thromboses of arterial vessels with necrosis of tissues or hemorrhage from the rupture of damaged vascular walls are seen as late sequelae. Similarly meningeal or cortical brain damage may follow the passage of a current through the cerebrospinal fluid. A flat bone, such as the skull, presents a large surface of high resistance. Intense heat is generated which may, as in the case of our patient devitalize large areas.

Survival of the patient is determined more by the path which the current takes through the body than by its intensity. The points of entrance and exit are significant and receive the most intense effect. Contact with ground at the moment of the accident is also an important element. There is general agreement that a current passing through the chest is most likely to be lethal because of its effects upon the heart. On the contrary, passage of a current into one foot and out the other has never been reported to be lethal. In our patient the

course of the current from scalp to left hand, thus by-passing the thorax, was a fortuitous circumstance. Excellent discussions of electropathology are contained in the articles by Pearl<sup>8</sup> and Jaffe.<sup>5</sup>

Electric burns have certain characteristic features. The tissues are heated momentarily to the fantastic level of an electric arc which may be 5500°F. to 7000°F. There is complete coagulation of tissues within a circumscribed zone but the systemic effects of extensive burns from sources of lesser intensity are absent. The barriers to bacterial invasion are sealed and infection is not likely to be a serious consideration. It has been proposed that limited areas of a burn might be excised and skin grafted immediately. However, as pointed out by Edwards and Bowie<sup>4</sup> and as illustrated in this case, the extent of the damaged blood supply cannot be estimated immediately and it is preferable to treat conservatively until the slough is well demarcated. The case reported by Smith and Rank<sup>9</sup> of the survival of an Australian soldier whose burns required amputation of an arm and two legs indicates that recovery may follow even very extensive electric burns. The method of plastic repair utilized in this patient is one of several which might be employed. We were faced with a situation in which a very scanty blood supply was available from the margins of the surface defect and none at all from its bed of devitalized skull bone. The full thickness of scalp which was shifted backward carried a bilateral vascular supply through the temporal arteries. This flap of scalp remained viable even though its lower edge was detached from its anchorage to the skin of the neck.

Traumatic cataracts are a recognized sequel of electric injuries. Adam and Klein<sup>1</sup> have compiled fifty such cases from the literature. They have usually been observed in patients who received electric burns of the head although occasionally the flash which occurs at the moment of contact may be responsible alone without any actual surface burn. Arc welders

and workers at blast furnaces also develop cataracts. These cataracts have been noted to appear from three weeks to two years after injury. The involvement is first observed in and usually remains confined to the anterior capsule. Choroiditis is often an early complication as in our case, but the cataract is not considered to be secondary to this nor is it due to albuminous coagulation. It is generally believed that the electric discharge destroys the capsular epithelium with consequent accumulation of fluid between it and the lens fibers. These cataracts may require as long as three years to reach maturity. An awareness of their occurrence and of early and continued ophthalmologic observation is obviously important. Some cases require operation, particularly if the involvement is bilateral.

Damage to the central nervous system by the passage of an electric current has been studied extensively in both experimental animals and electrocuted humans. There are immediate thermal effects and late degenerative sequelae. The case discussed herein illustrates initial trauma to the occipitoparietal cortex, brain stem and cerebellum with partial recovery. Alexander<sup>2</sup> and others have described patients who developed localized muscular atrophies months after injury. These are considered as manifestations of focal areas of encephalomalacia resulting from vascular damage and its consequent anoxia. In general both types of lesion appear in proximity either to vascular channels or to pools of cerebrospinal fluid. This is to be expected since blood and cerebrospinal fluid are excellent conductors of electricity and the walls of the channels through which these fluids circulate generate an intense heat proportionately to their greater resistance. The microscopic alterations in brain tissue vary considerably. Langworthy<sup>7</sup> has described focalized destruction of cells especially in the medulla, cerebellum and the cerebral cortex and also perivascular areas of hemorrhage. Following lethal exposures there may be quite startling disruptions not only of individual cells but of entire tissue planes as if the brain had been subjected to an internal explosion.

There is one characteristic electrocution injury which deserves passing comment. Burrows<sup>3</sup> and others have reported a number of cases of fracture or fracture-dislocation of the upper end of the humerus by violent muscular

contraction without direct trauma. In most instances these accidents have resulted from the short circuit of an ordinary house current when some appliance such as an electrical vibrator or a washing machine was used. Not infrequently the victim is momentarily rendered unconscious; if not, he finds himself unable to loosen his grasp upon the electrical appliance. The fractures produced are extensively comminuted and may be bilateral. Another type of fracture in which delicate lines of cleavage are visible to the naked eye but not apparent roentgenologically has been described by Jelinek<sup>6</sup> in cases of lethal electrocution.

#### CASE REPORT

N. I., aged twenty-two years, was on the roof of a house which was being moved, fending off overhanging electric wires with a stick held in his right hand. It appears that he was grasping a metallic strip along the ridge of the roof with his left hand. The day was clear and dry (no rainfall for at least a week with a low relative humidity of 30 to 40). A wire, carrying a single phase direct current of 7,200 volts, made contact with the metal strip along the ridge of the building. The patient later recalled a blinding flash and believed that as he recoiled the back of his head touched a second high tension wire. Dr. P. L. Allen of Weatherford, Texas, saw the patient on February 10, 1947, within ten minutes of the accident. There had been no respiratory arrest and artificial respiration was not required. The current had produced a severe burn at the point of entrance on the scalp and complete desiccation of the left arm almost to the shoulder. The left arm was disarticulated at the shoulder on the day after injury. He was stuporous and blind until the fifth day when he regained consciousness and could perceive gross objects.

He was transferred to the Veterans Administration Hospital on the fifth day after injury with a deep burn of the scalp and back of the neck. It was sharply delimited and measured about 13 by 26 cm. He was confused and showed marked dysmetria, adiadochocinesia, hyperactive tendon reflexes and a sustained clonus of both ankles. His vision was greatly diminished; he had acute conjunctivitis and iridocyclitis and the optic discs were indistinct.

The scalp sloughed rapidly, denuding an area measuring 13 by 20 cm. and including the entire occipital and about half of the parietal bone. It was obvious that unless this exposed bone could be covered quickly an extensive section of cranium directly over the cerebellum and brain stem would be lost. The patient was in good general condition and, contrary to earlier predictions, seemed to



have an excellent chance for survival. There was no suitable base for a free skin graft. Therefore, despite the necrotic condition of the tissues on the back of the neck, it was determined to attempt to cover the exposed cranium by detaching the scalp along the hairline at the brow and sliding it backward over the defect. The blood supply of this flap of scalp would come entirely from the temporal arteries since there were no available vascular sources on the back of the head. On February 28th an incision was carried from in front of one ear across the vertex at the hairline to a corresponding point in front of the other ear. The scalp was freed from the pericranium to which it was firmly congealed, slipped backward and anchored somewhat precariously to the damaged tissues at the back of the neck. The denuded area was covered anteriorly by split thickness skin grafts taken from the front of the thigh. An error was committed in not immobilizing the head after this operation. In consequence of this and the poor vitality of the cervical tissues the suture line gave way and the scalp retracted somewhat, leaving a portion of the occipital bone and a crescentic area on the back of the neck exposed again. We had been successful, however, in providing cover for more than half of the previously exposed skull. The bone which now lay uncovered in the wound measured 9 cc. transversely by 5.5 cc. vertically. It showed no indication of viability and it was conceded that it would eventually sequester. On March 28th an attempt was made to obtain vascularization from the underlying dura by making burr holes through both tables of the bone. There was no bleeding from these drill holes and for months thereafter their appearance remained unchanged with no evidence of granulation tissue. At about this time the posterior aspect of the neck was successfully covered with split thickness grafts.

Throughout this period and during ensuing weeks the patient had mild fluctuations of temperature with peaks never exceeding 100°F. His hemoglobin was maintained within a range of from 13 to 16 Gm. by a series of blood transfusions. He was ambulatory and at times left the hospital on leave. Penicillin and sulfadiazine were given intermittently in preparation for and following operative procedures. On three occasions (in April, September and October) he complained of severe headache, photophobia, dizziness and on one occasion showed nuchal rigidity; but he always had a sterile cerebrospinal fluid.

After taking counsel with several plastic surgical consultants an attempt was made to swing a pedicled flap from the interscapular area to the occipital defect. This required transfer of skin over a considerable vertical distance with no intermediate site to obtain good secondary vascularization. The attempt, made in several stages during

November, 1948



FIG. 1. Lateral x-ray showing the occipital sequestrum and still larger cranial defect which extends forward in the midline to the foramen magnum. After removal of the sequestrum the exposed meninges were covered by sliding the scalp backward from the browline.

May and June, resulted in loss of the entire flap, leaving the situation as before. It was then decided to revert to the scalp transfer method which previously had been partially successful. This was planned with the idea of removing the portions of skull which might sequester later. There were several postponements due to episodes of upper respiratory infection and of meningismus during which sequestrum formation occurred in a portion of the skull. Therefore, on October 15, 1947, a sequestrum extending from the occipital protuberance forward to the foramen magnum was gently removed with rongeurs. It was observed that the coagulating effect of the burn had penetrated the skull and that the dural sinuses in the vicinity of the torcula were thrombosed. Once again the scalp was freed at its anterior border and shifted backward about 5 cc. to cover the freshly exposed meninges. (Fig. 1.) A split thickness graft was placed anteriorly upon the denuded pericranium and this time a massive head and body cast of plaster was applied to immobilize the head in extension for ten days. This procedure was successful and the patient, completely healed, was discharged on December 12, 1947. (Fig. 2.)

The nuchal muscles which attach to the base of the skull had been replaced by cicatrix. Although the patient appeared to have strong extensor power, it was feared that a sudden jar or violent flexion of the head might produce an occipito-atlantal dislocation. Therefore, prior to discharge he was provided with a light plastic collar which would maintain the head in mild extension and at the same time afford protection over the occipital skull defect. As was anticipated, the patient has not worn this brace since discharge and at the present time he is driving a farm tractor. It was considered inadvisable to plate the skull defect





FIG. 2. The scalp has been moved backward twice to cover the occipital defect and the pericranium resurfaced with split thickness skin grafts taken from the thigh.

inasmuch as the rim of such a plate would constitute a margin of the foramen magnum. In this location, unless absolute permanent fixation of the plate could be secured, fatal medullary compression might occur with any displacement of the plate.

Reference has been made to the impairment of vision and the acute inflammation of the eyes evident at the time of the patient's admission. During the early months after injury there were recurrent attacks of iritis and the gradual development of lenticular opacities and optic neuritis was noted. After ten months there were definite cataracts in both eyes, the opacity in the right eye being more extensive. Fundi at this time showed a pallor of the discs with pigmentary deposits in the perimacular zones. Two months later the cataracts were static but the pigmentary changes in the retina were still progressing. When last seen in May, 1948, (fifteen months after injury) the patient's vision was 20/70 in both eyes but could be corrected to 20/30 in the right and to 20/40 in the left eye. The anterior portion of the eye was normal. Lenticular opacities mainly involved the anterior subcapsular area bilaterally and slightly involved the posterior portion of the capsule in the right eye. Although present in both, optic atrophy was more pronounced in the left eye. In

that eye there was complete disorganization of the macula, pigment absorption and peripapillary atrophy. The visual fields were constricted and showed a central scotoma bilaterally and on the left a temporal hemianopsia. These visual defects were regarded by Dr. Maxwell Thomas, ophthalmologic consultant, as due to a peripheral macular rather than a central lesion.

Immediately after injury this patient showed signs of severe injury to the central nervous system, particularly involving the cerebellum and brain stem. After ten months he complained of mild frontal headaches after exertion. Cerebellar incoordination had improved but he had a tendency to fall to the right in walking and there was nystagmus on right lateral gaze. All tendon reflexes were hyperactive and there was sustained bilateral ankle clonus. The indications at this time were of severe damage to the occipital lobe, moderate upper motor neuron disturbance and mild injury to the cerebellum and parietal cortex. It was noted by Dr. Carroll Kern, neurosurgical consultant, that the patient's residuals were amazingly small considering the amount of bone and soft tissue destruction and the observation that the torcula and both transverse sinuses were thrombosed on the dura beneath the occipital bone.

When observed fifteen months after his injury, the patient was slightly ataxic but this was scarcely noticeable in his gait. He walked on a slightly wide base but was able to do 3 miles without fatigue. His sensation and hearing were entirely normal. Manifestations of cerebellar disturbance were greatly improved and only a minimal nystagmus remained on looking far to the right. Tendon reflexes were increased bilaterally. There was an unsustained patellar clonus and a gross sustained ankle clonus bilaterally. The Babinski reflex was strongly positive but confirmatory Chaddock's and Gordon's signs were negative, placing the motor tract damage mainly in the brain stem. Despite the improvement with the passage of time, some of these residuals are expected to be permanent although only slightly incapacitating.

#### SUMMARY

In the case reported a man received a severe electric burn of the head and arm from contact with a wire carrying an electric current of 7,200 volts. Although his left arm had to be amputated at the shoulder, he survived the injury. The burn on the back of his head was grafted by detaching a double pedicled flap of scalp at the hairline of the brow and sliding it backward to be attached to the skin of the neck. Virtually the entire occipital bone sequestered and was removed. He developed bilateral cataracts and optic atrophy. The brain underlying the burned area was injured,

leaving him with obvious, but diminishing residuals of occipital lobe, cerebellar and parietal cortex damage.

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## DISCUSSION

RALPH CAROTHERS (Cincinnati, Ohio): I would like to emphasize one point Dr. North made. Men come in with electrical burns and all you see is a little black spot on an arm or leg which does not look much different from a cigarette burn on a white tablecloth. The house man or intern will want to excise it and close it either with a little graft or bring the edges together. The point is that I cannot tell and I do not believe anybody else can tell how extensive that slough will be. It may go from a  $\frac{1}{4}$  to 6 inches across before it is finished. Furthermore, if a patient has one of these burns on an arm or leg, it is a wise precaution to apply a tourniquet loosely to the limb above because you may need it in an awful hurry.

JAMES BARRETT BROWN (St. Louis, Mo.): Dr. North's demonstration of how to take care of a patient deserves great commendation. He did not give up in the face of great difficulty and the man is alive and well.

There are some technical points that might be of interest. If a flap is over dead bone, that bone, of course, will not revive and it will have to be taken out later. As Dr. North said, he knew this bone would have to be removed.

We have made mistakes thinking perhaps we could get a flap to work over dead bone, relying on later sequestration from under the flap; but over the face the flap is too apt to wrinkle up and possibly not be sufficient, so that in working around the face, it is probably best not to put flaps over dead bone. Dr. North recognized the fact that the bone was going to come out, and on this flat surface

this plan has probably saved a good deal of time for the patient.

Another thing of importance in work around the scalp and skull is that when flaps are raised it is highly important not to get the periosteum off the bone; because if it is raised or lost, a wound will be left that will not heal for a long time; when it does heal, it will be discolored and glazy with thin epithelium; and if it is on the forehead, it will be very unsightly. In taking up the flaps in his patient, Dr. North realized the importance of the intact periosteum and had an adequate base to pick up a free skin graft.

Another interesting point is a comparison of civilian and military lesions. There is not much difference except that civilian lesions sometime seem worse than military lesions. The main differences we could make out were that military lesions are apt to be quite dirty and in time of war multiple wounds from shell fragments occur that practically are not seen in civil life. Both Dr. Blocker, with his tremendous experience in the Texas blast, and Dr. Mason, with all the work he has done on damaged hands in his clinic will possibly agree.

In the war thousands of burns occurred and many of them were electrical burns. They usually did not occur from enemy action but from the usual mistakes and carelessness that accounts for civil accidents. About 83 per cent of the burns we saw in the war were due to someone's carelessness and not to enemy action. These lesions occur in civil life just the way they do in the housekeeping of troops, and the anatomy, physiology and pathology are the same in either situation.

This completely charred arm that Dr. North had to deal with, of course, had to be taken off. He spoke of the damage to blood vessels, and Doctor Carothers warned of the sudden, severe and sometimes fatal hemorrhage that can occur from the arteries higher up in the extremities. Repeated hemorrhage frequently occurs in these extremities.

I would like to say something about amputation for thermal burns (not electrical burns). In a plastic surgery center the philosophy of treatment should be the opposite of amputation. Here an effort should be made to build up parts and amputations done only at the last moment. At no time during our Army work in plastic surgery were any amputations done for burns that I know of; occasionally we removed a finger or so but no major amputations were done.

There was evidence that the Germans did not believe as we did. We heard of some instances of Germans having both hands cut off because of burns, and we had one American soldier who had had this treatment in a German hospital. This radical procedure practically should never be done. It would be much better just to wait; and even if only one digit were left, it should be saved instead of taking off the whole hand or arm.

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A PRACTICAL JOURNAL BUILT ON MERIT

Fifty-seventh Year of Publication

VOL. LXXVI

DECEMBER, 1948

NUMBER SIX

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## Editorial

### Presidential Address

#### THE PRESENT STATUS OF PROCTOLOGY AS A SURGICAL SPECIALTY IN THE UNITED STATES

GEORGE H. THIELE, M.D.

Kansas City, Missouri

THE specialty of proctology in the United States was born in 1899 with the founding of the American Proctologic Society at Columbus, Ohio. For almost fifty years our members have worked in behalf of our specialty but it is true, nevertheless, that in all probability this Society will celebrate its fiftieth anniversary only as the parent of a subspecialty of general surgery, having failed to produce an independent specialty. We must admit that so far general surgery, foster parent of proctology, has controlled its destiny. The American Proctologic Society is not entirely without blame for this situation.

In three important respects this Society has failed to fulfill its obligations to its members: (1) It has failed in its efforts to obtain an independent Board of Proctology; (2) it has failed to promote and activate an adequate teaching program for the undergraduate medical student, to provide adequate residency training for the graduate student and to provide a broad educational program for the benefit of those general practitioners and surgeons who wish to learn more about proctology; and (3) it has failed to provide adequate opportunities for membership in this Society. Let us consider the first of these failures,

namely, the problem of certification through an independent Board of Proctology.

#### THE AMERICAN BOARD OF PROCTOLOGY

If we are ever to certify an adequate number of proctologists, we must correct the inequalities which now exist in the provisions for the certification of proctologists. The present requirements of the American College of Surgeons and of the American Medical Association make it almost mandatory that a recognized training program be under the direction of a specialist who is a diplomate of an official examining board. It requires no great intelligence to reason that without a Board of Proctology there can be no diplomates, hence no acceptable teachers, hence no students and, therefore, no new proctologists. It is as simple as that.

Therefore, we may properly spend some time considering the reasons why proctology has been unable to attain an independent maturity as have the other surgical specialties and to outline, if possible, the correct procedures to be followed if we are to attain the status of an independent specialty whose members are certified by an independent Board of Proctology.

As a matter of comparison we should review the histories of the other surgical spe-

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cialties. I shall first name the specialty board, then give the date of its official approval by the Advisory Board for Medical Specialties and then follow with the number of diplomates as of July, 1947.

The American Board of Ophthalmology, 1917, 2,564; the American Board of Otolaryngology, 1924, 4,000; the American Board of Obstetrics and Gynecology, 1930, 2,137; the American Board of Orthopedics, 1934, 1,042; the American Board of Urology, 1935, 1,136; the American Board of Surgery, 1937, 2,904, of whom only 75 are certified in proctology; the American Board of Plastic Surgery, 1937, 171; and the American Board of Neurosurgery, 1940, 190.

The American Board of Proctology was incorporated in 1935, two years before the incorporation of the American Board of Surgery and immediately applied to the Advisory Board for Medical Specialties for official status as an approved independent Board of Proctology. Our representatives were asked to await the organization and incorporation of the American Board of Surgery and seeing no reason why this request should be refused consented to wait until the American Board of Surgery was approved. However, just as soon as the Board of Surgery was officially approved in 1937 our difficulties began. Even though our incorporation antedated that of the Board of Surgery by two full years the newly approved Board of Surgery maintained that proctology, being a subspecialty of general surgery, was not entitled to an independent examining board. Ever since 1937 proctology has been under the dominance of the American Board of Surgery upon which Board, however, we are not privileged to be represented. Finally, in 1941 we were granted a status subsidiary to the Board of Surgery through the formation of a Central Certifying Committee in Proctology but to this date we have no representation on the Board of Surgery and hence, no voice whatever in the formulation of the rules under which we function. As far as American medicine is concerned the principle of taxation without representation was not abrogated when the Colonies won the Revolutionary War. As matters now stand our diplomates are required to meet higher standards than are required of those of any other surgical specialty including those of the American Board of Surgery itself. Each diplomate of the Central

Certifying Committee in Proctology must first pass both examinations of the American Board of Surgery before he is qualified to take the examinations of the Committee. These requirements are imposed upon no other surgical specialty Board.

Let me make our position clear. We are not asking for nor do we want the "bars let down" so to speak. Proctology is a surgical specialty and as such its diplomates should first of all be thoroughly trained surgeons but they should not be required to be supermen. There is no reason why a proctologist should be forced to qualify in surgery of the thyroid or why he should be required to prove his ability to perform a gastric resection any more than should the orthopedist, the urologist or the gynecologist.

You are all familiar with the long-continued efforts which have been made by your representatives who have appeared before the Advisory Board for Medical Specialties with the request that we be granted an independent Board of Proctology. Year after year those representatives have been sent from the Advisory Board to the American Board of Surgery only to be referred back to the Advisory Board. To use a slang expression, we have been the victims of the most artful example of "buck-passing" in the annals of organized medicine. Our efforts have been dealt with on a basis of power politics rather than on one of merit and justice. The Advisory Board for Medical Specialties, composed of representatives of all of the specialties, has become so engrossed in its own problems that it has failed to appreciate the fact that as long as the Board of Proctology is under the dominance of the American Board of Surgery it cannot function efficiently.

Each of you received a copy of the petitions which were presented to the Advisory Board by this Society and by the Central Certifying Committee in February, 1948 outlining our position and our arguments. As a result of those petitions the Advisory Board recommended to the American Board of Surgery "the establishment of a subsidiary or affiliate Board within the American Board of Surgery and that those desiring certification in Anorectal Surgery only be certified in that field without having to take the entire examination in General Surgery, but that those who wish certification in Proctology and Colon Surgery

shall continue to take the examinations in General Surgery as was recommended last year; and in the event that the American Board of Surgery should not wish to accept this recommendation, the Advisory Board further recommended that proctologists and colon surgeons be given an independent Board."

Apparently we have been successful in our efforts to provide for the official certification of those men who wish to limit themselves to anorectal surgery.

We may be sure that the reasons for our failure to obtain an independent Board of Proctology lie in part in our own shortcomings. We cannot remain idle for nine months of the year grumpily contemplating our troubles and expect to attain our objectives. We might just as well make up our minds right now that this job of securing an independent Board of Proctology is a year-around task which is going to require activation of all the latent ingenuity we have. We cannot secure an independent Board by complaining about the attitude of the American Board of Surgery. Boiled down the elements of the situation force us to one conclusion, namely, that we have not welded ourselves into a sufficiently powerful organization to demand and to get what we want. Thus it is that although our representatives have worked since 1932 for an independent Board of Proctology, it has not yet been granted. While hope has grown gray, accomplishment is still only adolescent.

Why is it that the specialty of proctology has been unable to keep pace with the other surgical specialties in the attainment of recognition? The answer is to be found in this Society and in seeking it we are brought face to face with the second of our obligations—that of providing teaching facilities.

#### TEACHING FACILITIES

Proctologic teaching has not kept pace with the constantly increasing fund of proctologic knowledge. In common with that of the other specialties proctologic teaching includes three phases: undergraduate instruction, postgraduate instruction, postgraduate residency programs and general educational programs through the use of scientific journals and medical meetings.

*Undergraduate Teaching.* For years this Society has had a standing Committee on Education which has done an admirable piece

of work. As part of its activities during the past year it has conducted a survey of proctologic teaching in Class A medical schools of the United States and Canada. Questionnaires were returned by sixty-five schools. This survey has revealed that proctology is being taught in fifty-four medical schools. In thirty-seven of these schools proctologic teaching is under the direction of a proctologist and in eleven schools there is a separate and distinct Department of Proctology headed by a proctologist with the rank of full professor. Questionnaires were not returned by sixteen schools, in seven of which it is known that proctology is being taught.

We must, therefore, follow up the work which has been done by our Committee on Education. In every city in which a Class A medical school is located one of our certified members should contact the Dean of that school and make every effort to initiate some kind of proctologic teaching if only the conducting of an out-patient clinic. It is a foregone conclusion that such a clinic will grow rapidly and will soon demand hospital surgical service. Increasing demands will eventually result in the organization of departments of proctology either independently or as divisions of the departments of general surgery. As a result of proctologic teaching some medical students will be attracted to our specialty. We should, therefore, make provisions for residency training programs.

*Resident Training.* Men who are associated with hospitals which provide acceptable resident training must provide proctologic training for residents. As of August 16, 1947, as published in the J. A. M. A., postgraduate proctologic training is limited to the facilities provided by only eleven different hospitals for thirty-four residencies and assistant residencies. In addition to the graduate teaching facilities provided by these residencies there are facilities provided by a few privately conducted short courses in several different localities and refresher courses by a few university medical schools.

Although forty-three different cities are represented by the diplomates of the American Board of Surgery in Proctology through the Central Certifying Committee, resident training is available in only eleven different cities. This means that thirty-two additional residencies could be instituted. The solution is

obvious. The conclusion is that we are simply not working hard enough to provide proctologic resident training in our own institutions.

*General Educational Program.* The scope of the educational program of this Society must include some provisions for the great mass of medical men who do not hope to qualify as certified proctologists but who have developed an interest in proctology, who have not had available training in medical school or as postgraduate students and who wish to improve the quality of proctologic practice which they are doing as general practitioners and surgeons. To this group of men we owe a distinct obligation and by raising their standards we shall raise the general status of our specialty. This field offers perhaps our greatest chance to make ourselves heard in American medicine.

My suggestion for a solution of this problem is that a subcommittee on curriculums be appointed to serve as a part of the committee on education. The members of this committee should be men who have been actively engaged in teaching proctology. This committee's duty should be to formulate an official course of study for the instruction of those interested in proctology. Teaching facilities should then be set up by this Society in approximately twenty-four cities throughout the country. The men within these areas can then be assigned the uniform course of study and can congregate once a month at these teaching centers for sessions with a diplomate of our board or with a fellow of this Society. Wet clinics can be held. At the end of two years of such supervised study it might be desirable to grant a certificate of some type after the examinee has passed a suitable examination formulated by the committee on curriculums. Thus the seeds of proctology can be broadcast.

I realize that this is a big program. Big tasks, however, demand big programs. Every privilege which we enjoy is conditioned upon a responsibility; if we are to have the privilege of seeing proctology attain what to us seems its rightful place, we must accept the responsibility for some such teaching program.

*Medical Meetings and Scientific Papers.* There is one more important way in which we can demonstrate to the medical profession our right to the status of an independent specialty. This is by the exercise of extreme care in the presentation of scientific papers before county, state, regional and national medical societies.

Nothing else will so quickly sound the death knell of the specialty of proctology as the publication of a mass of poorly written papers on time-worn subjects about which recent textbooks supply all of the authoritative information. Textbooks are written for just that purpose. I think we may use the subject matter of this meeting as a fair example. I believe that the papers presented at this meeting will go far in demonstrating to the surgical profession of this country that proctology has outlived its growing-pains and has at last reached a maturity where it may be expected to produce enough well trained proctologists to fulfill the need which exists. For the benefit of the younger men whose experience in medical writing is necessarily limited I believe that we should provide a consulting editorial committee to which they can submit ideas they may have about proposed scientific papers and whose help will be available in the composition and preparation of such papers.

#### MEMBERSHIP.

The problem of membership in the American Proctologic Society has become one of increasing importance both to the applicants and to our Society. At this meeting we are entertaining as guests about 200 young men who because of their interest in proctology have requested guest cards. We are particularly glad to have these men with us but the problem of selection and of acting upon the applications for membership has become an increasingly difficult one. Your council has just spent the greater part of three days carefully investigating every one of these 200 applications for membership. The task has become too great to be assumed by such a small group. While the chance for error is small, I believe it is still too great. Not a single applicant should be done an injustice.

I suggest, therefore, that we divide the country into twelve zones and that a regional membership board be established in each zone. Such an arrangement will permit each of these boards an almost personal contact with its applicants for membership. Reports from regional boards may be made to the council and recommendations from the council made directly to the fellowship.

#### COMPONENT SOCIETIES

There are now eleven organized proctologic societies in the United States. This is a very

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healthful trend. No tree is any stronger than its roots. I would strongly advise, therefore, the organization of more local, state and regional societies and would further recommend that when such societies have been organized membership in the American Proctologic Society be contingent upon prior membership in one of these secondary organizations. This will help to provide the solution of the problem of selecting the membership of this Society from the applicants.

#### CONCLUSION

I have considered only a few of the more important problems pertinent to the present status of American proctology and have suggested what seem to be the obvious solutions. One fact is certain: The Society must make a more concerted and sustained effort to improve our present situation or be forever content to remain as we are now, a step-child of general

surgery and a half-brother to the other surgical specialties. Our situation is not hopeless. It can be improved and we can secure an independent Board of Proctology. The task is ours; we should carry on and accomplish it.

Since this editorial was written the secretary of the Central Certifying Committee in Proctology has been advised through a letter dated June 9, 1948, from Dr. J. Stewart Rodman, secretary of the American Board of Surgery, that the Board of Surgery decided at its annual meeting that it "could not accept the recommendation made by the Advisory Board to the effect that for one group, those wishing to practice ano-rectal surgery only, a special examination be arranged so that they would not have to pass the same examination in general surgery that has been required in the past."

This should mean that proctologists will be given an independent American Board of Proctology after complying with the requirements of the Advisory Board for Medical Specialties in the essentials and organization of such a Board.





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# Papers of the Scientific Sessions

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## COLLOID ADENOCARCINOMA INVOLVING THE PERIANAL REGION, ANUS, RECTUM OR SIGMOID COLON

JOHN R. HILL, M.D. AND NEWTON D. SMITH, M.D.

Section on Proctology, Mayo Clinic  
Rochester, Minnesota

IN our work in the Section on Proctology at the Mayo Clinic we have observed that some colloid adenocarcinomas present peculiar diagnostic problems. These problems are more serious and more difficult than those presented by adenocarcinoma in which colloid material is not observed. Other physicians also have had difficulty in making the diagnosis in cases of colloid adenocarcinoma of the distal part of the intestinal tract. Although this problem does not arise frequently, we proctologists must recognize it and contribute more to its satisfactory solution because failure to solve it carries an increased hazard for the patient.

### MATERIAL STUDIED

Thirty-eight cases of colloid adenocarcinoma in the perianal region, anus, rectum or sigmoid colon have been selected to illustrate our observations. We studied 321 cases but this smaller group of cases (11.8 per cent of the total group) illustrates best the problem we are anxious to present. In most of the other cases the diagnosis was made more promptly and without much difficulty because of the clear cut gross pathologic picture. All except one of 321 patients were examined sigmoidoscopically. The one exception had an extremely painful anorectal lesion, presumably an epithelioma.

### OBSERVATIONS

The proportion of males to females in our group of thirty-eight was not unusual; there were twenty-five males and thirteen females. The age distribution, however, are unusual. Whether this would maintain in a much larger group may be doubted but still it is peculiar

in this group and worthy of attention. Eleven of the thirty-eight patients were less than forty years of age and of these, six were less than thirty years old. Nine of the patients were in the fifth decade of life, eleven in the sixth, four in the seventh and two in the eighth decade.

Rankin and Chumley<sup>1</sup> observed that colloid adenocarcinoma appeared most frequently in the rectum, rectosigmoid, cecum and ascending colon. Because the lesions appear most frequently in the most distal portion of the colon, it might seem that the patients would observe symptoms early and, therefore, seek medical advice promptly. This was only approximately true in our group of thirty-eight patients. Twenty-one were examined during the first six months after the onset of the symptoms and eight in the second six months. The colloid adenocarcinomas of four patients occurred in fistulas which had been present for twenty, eighteen, sixteen and two years. In the case in which the fistula was of only two years' duration the malignant lesion could have been present when the first symptoms were noticed but in the other three cases it seems permissible to conclude that the malignant lesion occurred in a fistula. This is further proved by the history obtained from each of the three patients. Each had observed increased activity and also a variation in the response of the tissue to the therapeutic measures which previously had relieved the discomfort.

Diagnosis of colloid adenocarcinoma involving the perianal region, anus, rectum or sigmoid colon is often delayed because the lesion may simulate a benign or inflammatory pathologic process. In thirteen of our patients the colloid adenocarcinoma resembled a benign

stricture and only after the removal of a satisfactory specimen for microscopic examination was the correct diagnosis possible. Seven of the lesions resembled anal fistulas or wounds which usually result from fistulectomy. Five of the colloid adenocarcinomas closely resembled diverticulitis when observed proctoscopically and disclosed the malignant nature of the lesion only at the time of surgical abdominal exploration or colostomy to relieve the obstructive symptoms. Four of the patients had rectovaginal masses which resembled abscesses or benign lesions and three had ulcerative lesions involving the anus. An ulcerative lesion in the rectum of one patient was diagnosed as a tuberculous ulcer and another patient was treated for chronic ulcerative colitis. Two of the patients had lesions which appeared peculiar and no diagnosis was attempted until the pathologist had the opportunity to examine a specimen removed at the time of proctoscopic examination.

Two patients had colloid adenocarcinoma (Broders' classification), grade 3, closely associated with an adenocarcinoma, grade 1, in which colloid material was not evident. In another case a squamous cell epithelioma of grade 1 and a colloid adenocarcinoma of grade 4 were observed. Still another patient had a low grade 1 papillary adenocarcinoma in which colloid material was not evident associated with a colloid adenocarcinoma of grade 4. An adenoma was also observed in the sigmoid colon of a patient who had a colloid adenocarcinoma, grade 3, of the rectum. These observations concur with those made previously by others that a colloid adenocarcinoma frequently is not a lesion with a homogeneous growth of cells. Some of the lesions may appear to be non-colloid adenocarcinoma in one portion and pure-colloid adenocarcinoma in another.

The imperative need for prompt, accurate observation and evaluation of findings is impressively illustrated when we consider the following brief summary of pertinent information. During the undoubted presence of the colloid adenocarcinoma six of the thirty patients underwent hemorrhoidectomies and two had fistulectomies. One patient's anus was dilated during this important period. Local excision of a tumor was accomplished in another case and roentgen therapy was employed in one case. It is true that the last two

patients had been treated for the serious lesion but in the presence of a colloid adenocarcinoma such treatment is never satisfactory. One other patient was examined by several physicians all of whom detected a pelvic mass but by the time operation was attempted, the lesion had become inoperable.

The seriousness of this lesion is illustrated by the fact that seventeen (45 per cent) of the thirty-eight patients were dead in less than a year after the diagnosis was made. Six died during the second year, seven during the third year, three during the fourth year and one during the sixth year. One patient lived twelve years after the diagnosis of colloid adenocarcinoma but ultimately succumbed to the carcinoma. One patient is still living three years and ten months after operation. One patient was apparently cured but died in an accident and another is still living fourteen years after fulguration of the involved region. Another patient is still living after having undergone palliative surgical measures. Two of the patients have not been accounted for but both presumably have succumbed to the colloid adenocarcinoma because one refused surgical intervention in spite of the fact that he had an extensive lesion and the other at the time of posterior resection proved to have a colloid adenocarcinoma, grade 3, with involvement of the entire thickness of the wall and adjacent glands.

A brief review of the treatment employed in this group of cases gives material for a plea not only for radical surgical procedures but for their accomplishment early enough to save lives. It is unreasonable to temporize or be timid in view of the facts. If it can be assumed that posterior resections, anterior resections, abdominoperineal resections and a Harrison-Cripps operation were all done with curative intent, twenty-three of our patients were treated with cure in view. Eleven were treated by colostomy or other palliative treatment and five were treated by the application of radium only after surgery. Fulguration was employed in two cases.

Another fact that impressed us was that colloid adenocarcinoma in the perianal region, anus, rectum or sigmoid colon invaded directly into surrounding tissue. A specimen removed for biopsy from the margin of the lesion, therefore, may show only inflammatory reaction and unless another satisfactory specimen is

promptly removed, much valuable time may be lost. If any lesion in this portion of the body is suspected of being malignant and the pathologist's report fails to confirm this suspicion, another specimen should be obtained promptly.

#### COMMENT

We would like to reiterate that colloid adenocarcinoma in the perianal region, anus, rectum or sigmoid colon is more serious than is frequently recognized. To save the lives of patients afflicted with this lesion earlier diagnosis must be accomplished and surgical intervention must be radical even when it is attempted early. No other form of treatment seemed to help except fulguration in two cases. Because of the anorectal surgery that was accomplished during the presence of the colloid adenocarcinoma, it seems inexcusable for any surgeon to operate on any anorectal pathologic process before a proctoscopic examination has been accomplished. Colloid adenocarcinoma in the regions mentioned may simulate other lesions less dangerous but this masquerade must be recognized early if a greater number of lives are to be saved than are saved at present.

#### REFERENCE

1. RANKIN, F. W. and CHUMLEY, C. L. Colloid carcinoma of the colon and rectum. *Arch. Surg.*, 18: 129-139, 1929.

#### DISCUSSION

JOHN D. CHARLES (Milwaukee, Wis.): My comments will only underline the unfavorable prognosis that Dr. Smith has had to insinuate.

With the help of my resident staff at the Milwaukee County Hospital we hurriedly went over the cases for the last ten years and found twelve cases involving the rectum and rectosigmoid, eleven of the rectum and one of the rectosigmoid. Five of these had surgery that was intended to be curative, one had palliative surgery and they are all dead.

In addition, there was one lesion of the cecum, one of the ascending colon, and two of the splenic flexure. One of the cases of the splenic flexure still survives, and, incidentally, there were six cases of gastric colloids all of whom had an early demise.

I shall just review one or two basic matters in connection with diagnosis and what the pathologic significance of colloid adenocarcinoma may be.

It seems that there are two types of colloid adenocarcinoma, one of which is primarily a collection of the mucinous material extracellularly and is relatively a benign disease. The fact that it

is a benign disease may be deceiving, however, because often certain parts of the tumor do form the more malignant or intracellular colloid type. This latter type is the type that is characterized by the so-called signet ring or goblet cell, with compression of the nucleus to a crescent or crescent-like shape. It is uniformly of highly malignant character.

It strikes me as particularly pathetic that each time a paper is given on the subject of malignant disease, it is concluded by some sad remark to the effect that more sigmoidoscopic examinations should be done and that many of these people are inadequately diagnosed. I would think that this organization should be the one that should exercise some more forceful attempts at bringing this problem to the attention of the general medical profession, surely, but perhaps even to the laity through some such medium as the Cancer Society, or however the Council of this Society might see fit. That, however, is a problem for the men who lay down the principles and policies of this association and I present it purely as a suggestion. Thank you! [Applause]

RUFUS C. ALLEY (Lexington, Ky.): Colloid adenocarcinoma or mucoid or gelatinous carcinoma can be a confusing tumor, as Dr. Smith so well pointed out, especially from the diagnostic point of view. Dr. Smith and Dr. Hill have given us an excellent résumé of this subject and have enumerated some of the more easily made errors that might be encountered in diagnosis.

Modern treatment of cancer of the large bowel offers the patient excellent prospects of cure provided diagnosis is established early and treatment instituted promptly. Today early and accurate diagnosis is the most important single step in the cure of cancer.

The differential diagnosis of colloid carcinoma is important and often difficult. As the essayists have indicated, it may easily be confused with benign stricture of the rectum, benign tumors or inflammatory lesions. Histopathologic studies by skilled pathologists are essential for accurate diagnoses.

In this connection I should like to emphasize the desirability of removing, when feasible, multiple biopsy specimens during the first examination. In many instances I have found it expedient to remove as many as five or six biopsy specimens from different parts of the same tumor during one session.

Probably most of you have had the same experience, as I, of taking a single biopsy specimen from a tumor that you believe perfectly sure is cancer and have the pathologist report, "inflammatory tissue," or, "no evidence of cancer." Then it is necessary to get the patient back and repeat the examination and the biopsy removal, and this can be done three or four times or more before the right part of the tumor is sampled. Cancer has a way of

producing an extension of inflammatory granulomatous tissue that is difficult or virtually impossible to distinguish by gross appearance through the sigmoidoscope, so on numerous occasions I have removed multiple specimens.

The pathologist will usually block the specimens in a group very much like the petals of a flower and make sections through all of the biopsy specimens. That gives him much more representative areas of the tumor for study, his findings are much more likely to be accurate and his opinion concerning the nature of the growth is therefore more valuable. I have done this numerous times and I have never yet had occasion to regret it. I have not encountered any complications, excessive bleeding or any other undesirable sequelae. This also relieves the patient of the necessity or rather the inconvenience of repeated preparation and examination.

I want to ask a question. Dr. Smith stated in conclusion that in four of thirty-eight patients, which is a little more than 10 per cent of these patients that he studied, the colloid cancer occurred in fistulas. I should like to ask if this high percentage applied to his entire series of 321 cases or whether it applied just to the thirty-eight cases that were selected for study.

N. D. SMITH (closing): I am sincerely grateful for the manner in which Dr. Charles and Dr. Alley have augmented my original discussion. To answer the question that was asked concerning the colloid carcinomas which occurred in fistulas, I may say that these particular cases have been reported elsewhere. Three fistulas were seen and the patients

afflicted with them were observed over a long period. So far as I know, the lesions are the only carcinomas that have occurred in fistulas while the patients were under our observation.

I should like to emphasize the fact that possibly we become a little tired of talking about the importance of sigmoidoscopic examination, but I believe it is only by continued talking that we can ever impress others with the importance of such a procedure. This method is probably the only one we have at the present time by which we can carry on any preventive medicine in the form of discovering lesions early enough to insure their removal and cure.

For emphasis, I should like to call your attention again to the fact that our interest in this group of patients was aroused because we had difficulty in making diagnoses. The patients frequently were referred to us because they supposedly had benign strictures. Grossly, such appeared to be the case. Since, however, we were puzzled by the persistence of the lesion and the late appearance of it, we were of the opinion that we needed to study tissue removed directly from the lesion itself. I think it is still important to remember the mimetic features of the lesion. In the future, colloid carcinomas must be excised radically without attempts to save tissue. Realization of this fact is important because radical excision presents the only means of assuring cure since the lesion tends to spread more rapidly into the surrounding tissue than do other types of adenocarcinoma. Simple excision in fact rarely accomplishes much good.



# CHOICE OF OPERATION IN CARCINOMA OF THE LEFT HALF OF THE LARGE BOWEL

RAYMOND W. MCNEALY, M.D. AND FRANCIS D. WOLFE, M.D.  
*Chicago, Illinois*

THE consummate aim of each operation for carcinoma of the large bowel is to remove completely the tumor and adjacent tissues that might be involved. Immediate or delayed restoration of bowel continuity and sphincter control should be provided when possible but under no circumstances should one sacrifice completeness of dissection and resection in order to preserve sphincter control or avoid permanent colostomy.

In those portions of the left half of the large bowel that are easily accessible a wide resection with primary anastomosis is unquestionably the most desirable operation from the patient's standpoint. There are definite limitations, however, to use of this type of operation. It should never be employed unless the patient has had satisfactory and complete preoperative preparation. Even a mild degree of obstruction and consequent distention are contraindications to use of the operation. Retention of barium in the colon following previous roentgenologic examination makes primary anastomosis extremely hazardous.

If the bowel can be thoroughly decompressed by enemas, chemical biostatics will be given an opportunity to reduce the bacterial flora to a level compatible with primary healing and firm union of the cut ends of the colon. In addition to the local factors concerned in healing we have learned that the protein levels of the blood, the vitamin level and liver efficiency play a very important rôle.

There are certain mechanical and technical factors which must be observed. An adequate blood supply can usually be assured if one is careful to divide the mesentery in a manner that will not impede the free flow of blood to the cut ends of the bowel. The practice of crushing these ends which are later to be used in the anastomosis is unwise and unsafe. The anastomosis should be made with fine, interrupted sutures which accurately approximate each layer of the bowel wall. It has been our practice to use fine, non-absorbable sutures. Delayed diaphragm stricture formation is more

likely to develop when a continuous suture is employed and if excessive inversion is accomplished at the site of anastomosis. When anastomosis is performed below the promontory of the sacrum, only one row of through-and-through, interrupted, non-absorbable, fine suture material is used on the posterior wall; while the ends and anterior wall are reinforced with a second row of Lembert sutures.

If the patient has been prepared properly, postoperative management offers few difficulties. The stomach and small bowel are maintained in a state of decompression from eight to ten days by utilizing an indwelling nasal suction tube. The large bowel is prevented from becoming distended by the use of a retained, short rectal tube. It is important to see that the tube is kept patent at all times and we have accomplished this by introducing a small amount of air through the tube with a bulb syringe. This is done every three hours.

We insist that no patient who is to undergo a bowel resection be brought to the operating room unless he has had a fluoroscopic examination on the preceding day. If there is any evidence of barium or fecal material in the colon, the operation is postponed until the bowel is emptied of its contents.

There are certain cases which do not lend themselves to resection followed by primary anastomosis. Patients who have remained obstructed until their condition has assumed emergency proportions may require some type of immediate colostomy. This is particularly true if the proximal portion of the obstructed colon contains masses of feces or barium.

Almost everyone is familiar with the problem of decompressing the large bowel between the ileocecal valve and the left-sided lesion which produces complete obstruction. Nasal suction may empty the small intestine but the large bowel is more difficult to decompress. Fortunately, completely obstructive lesions are usually found in the lower portion of the sigmoid and upper part of the rectum. We have had considerable success with these patients

after the lower bowel has been cleansed by repeated enemas and after a proctoscope has been inserted carefully. In a number of instances we were able to pass a small catheter beyond the obstructing lesion. After distention was relieved we employed gentle irrigation of the large bowel proximal to the tumor and often were able to liquefy the contents and facilitate evacuation in that manner.

We oppose the employment of the Mikulicz procedure when the patient's condition is complicated by distention of the colon. Handling of the tumor and mobilization of sufficient bowel on either side of the lesion to permit the exteriorization is an extremely difficult task. There is always danger of leakage and the attempt to "double-barrel" the large bowel on either side of the lesion adds greatly to the risk. When sutures are placed in the distended, thin-walled, large bowel, the procedure carries great risk. We have employed the Mikulicz procedure only once in 266 consecutive operations for tumors of the large bowel.

The proper location of the colostomy cannot be overemphasized. Every effort should be made to determine the position of the obstructive lesion before colostomy is performed and the colostomy should be placed where it will facilitate subsequent operations. We are not enthusiastic about resections and primary anastomosis in the case of lesions situated at or very near the peritoneal reflection. When one attempts removal of tumors which are situated too low down, there is a tendency to sacrifice thoroughness for convenience.

Carcinomas located at or near the peritoneal reflection and those below this level belong to a group that are probably best managed by a one-stage, abdominoperineal resection. If a significant degree of obstruction exists, a primary colostomy is necessary. The abdominoperineal operation is similar to a panhysterectomy and is designed to facilitate wide excision of the pararectal tissues and mesosigmoid. If the one-stage resection is performed, the surgeon should be thoroughly familiar with the anatomic structures with which he has to deal. Dissection should be boldly but carefully executed. As much of the sigmoid and its mesentery as possible should be removed but sufficient bowel should be preserved to permit the establishment of a colostomy without tension.

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The advantages and indications for the various types of sleeve resections and so-called pull-through operations vary greatly with different surgeons. Briefly, it may be said that these operations are predicated on the belief that the direction of spread in carcinomas of the rectum is predominantly in an upward direction.

The advantages derived from surgical procedures in which a perineal-anus is established are: (1) the normal location of the stoma is more satisfactory; (2) a certain amount of sphincter control is preserved; (3) a smaller percentage of impotencies result than following other procedures.

In our series of 266 consecutive cases no leakage or fistulas have developed. The following procedures were used:

Type of Operation	No. of Cases	Per Cent
Permanent colostomy.....	18	6.8
Abdominoperineal.....	188	70.6
Primary anastomosis.....	50	18.8
Mikulicz.....	1	0.4
Treatment refused.....	9	3.4
Total.....	266	100

Even when metastases exist, we have employed colostomy alone less and less frequently. We have expended great effort in many instances in removing the primary tumor despite the presence of metastases. We believe that this is justifiable because it delays local extension and spread; extension to ureters, prostate, bladder and sacrum is less troublesome than when the tumor is left in place and a colostomy alone performed. No effort is made to resect the primary tumor when there is serious involvement of adjacent pelvic structures.

#### CONCLUSIONS

We have tried to adapt each operation to the requirements of the individual patient. Complete excision of the primary tumor with wide excision of the surrounding gland-bearing tissue has been our chief objective when operating upon resectable lesions of the colon. Reconstruction of the continuity of the bowel and preservation of sphincter control has been regarded as of secondary importance despite its desirability.

# SURGICAL MANAGEMENT OF LESIONS OF THE LARGE BOWEL

HARRY E. BACON, M.D. AND GEORGE D. VAUGHAN, M.D.  
*Philadelphia, Pennsylvania*

THE management of disease processes involving the large bowel and particularly its distal portion has been the subject of considerable discussion during the past decade. Our interest has centered chiefly with malignancy of this site. In a per-

TABLE I  
RESECTIONS

Type of Resection	No. of Cases	Deaths	Mortality Rate
Sigmoidectomy—multiple stage—Mikulicz-Rankin..	38	3	7.8
A. Sigmoidectomy—single stage—open or closed....	34	3	8.8
Sigmoidectomy—single stage—Hartmann.....	18	2	11.1
B. Abdominoperineal proctosigmoidectomy without colostomy and with preservation of sphincter musculature.....	401	20	4.9
Abdominoperineal excision—one-stage Miles.....	110	3	2.7
Abdominoperineal excision—two-stage Lahey.....	7	1	14.3
C. Colostomy and perineal excision Lockhart-Mumery.....	26	1	3.8
Perineo-abdominal excision Gabriel-Turner.....	2	0	0
Perineal resection Cuneo-Seneque.....	2	0	0
	638	33	5.1%

sonal series of 800 patients with cancer the distribution was as follows: sigmoid, 112; rectosigmoid, 261; rectum, 406; and anal canal, 21.

It has been our custom to estimate the rate of resectability on the total number of patients with neoplastic disease; whereas if calculation is made on the basis of the number operated upon as suggested by Pemberton,<sup>28</sup> Jones<sup>22</sup> and Babcock,<sup>1</sup> our resectability rate would be 88.0 per cent.

Our approach to the management of malignancy of the lower portion of the bowel may be described as follows: (1) All growths involving the mid and proximal sigmoid are removed by immediate establishment of intestinal continuity either by the open or closed technic, or the Mikulicz-Rankin method of exteriorization; (2) all lesions involving the distal sigmoid, rectosigmoid and ampullary portion of the rectum are extirpated by proctosigmoidectomy without colostomy and with preservation of both the internal and external sphincters; (3) those lesions involving the anal canal and lowest 3 cm. of the rectum are excised by methods in which the sphincter muscles are sacrificed and a permanent abdominal colostomy established. The technic usually chosen is the Miles abdominoperineal method of excision.

The types of resection employed in the treatment of the 800 patients with malignancy of the lower bowel is shown in Table I.

It will be noted that 76 per cent of the resections were performed without permanent colostomy and 69.6 per cent without any type of colostomy. The number of patients in our series on whom primary anastomosis was performed is small and the survival rate after five years cannot be determined. However, it is known that 52.6 per cent of the patients upon whom an abdominoperineal proctosigmoidectomy was performed were living five years or more following operation.<sup>8</sup> It should be stated that this group includes those patients upon whom palliative as well as non-palliative (curative) procedures, both favorable and unfavorable, were employed.<sup>7</sup> As has been reported elsewhere<sup>11,12</sup> the incidence of local recurrence in our series was 17.9 per cent.

*Benign Polypoid Lesions of the Sigmoid.* During the past few years an earnest attempt has been made to determine the most satisfactory procedure for the removal of solitary benign polypoid growths situated in the colon above the peritoneal reflection. Previously it had been our custom to remove such a lesion



by utilizing an electric snare and applying it through the sigmoidoscope. Until the time of this report our series included fifty-three patients in whom sigmoidotomy was performed. In several instances the polyp was visualized by endoscopic means. In other cases the growth was visualized by roentgenologic studies by employing the double contrast enema technic. During the performance of sigmoidotomy the abdomen is opened through a modified Cherney or Babcock diagonal incision, the sigmoid is slit through the taenia after precise measurement and the growth is removed between clamps which are applied at the base. The stump is inverted by employing a Cushing stitch. Through the incision a sterile sigmoidoscope is passed both proximal and distal in order to determine whether or not additional lesions are present. Following closure of the bowel streptomycin and penicillin are placed in the peritoneal cavity and a slump drain is introduced and allowed to remain in place for forty-eight hours. It is particularly interesting that of the fifty-three patients subjected to sigmoidotomy, twenty-seven or 50.9 per cent of the polyps were reported as grade 1, or grade 2 adenocarcinomas on serial section. There has been no evidence of recurrence to our knowledge. Customarily all patients are sigmoidoscoped and roentgenographed at six-month intervals. There were two deaths (3.7 per cent) early in our experience and both were due to pulmonary embolism.

*Chronic Ulcerative Colitis.* The rôle that surgery should play in the treatment of this devastating disease continues to be a problem born of disunity and uncertainty. It is difficult for any group of specialists, whether they are gastroenterologists, allergists, exponents of psychosomatic theories, colonic surgeons or those who favor the surgical procedure of vagotomy, to rationalize sanely and arrive at an appropriate conclusion regarding the management of chronic ulcerative colitis. We have been impressed particularly by the statement of Kieffer and Jordan<sup>23</sup> that the medical treatment of chronic ulcerative colitis must be regarded as a control and not a cure and further that the only actual cure now available is complete colectomy. As reported by Lahey<sup>24</sup> and Ferguson,<sup>19</sup> there is evidence at hand to prove that the mortality rate following medical management is approximately the same as that which follows surgical treatment. In the light

of our present knowledge surgical treatment must be considered a means of preserving life when acute sepsis is present and as a measure intended to rehabilitate those who are chronic invalids. It is our opinion that a thorough appraisal should be made of the condition of patients suffering with this disease and that they should be placed on a rigid medical regimen. Ileostomy should be performed whenever the condition is not amenable to this regimen because of sepsis and the course of the disease is characterized by remissions and exacerbations with uncontrollable diarrhea, impending perforation, chronic debilitating malnutrition and anemia. Whether or not hemorrhage warrants ileostomy is a moot question since we have all experienced at least one instance in which failure occurred.

Colectomy should be stressed for patients upon whom an ileostomy has been performed and who present signs and symptoms of persistent sepsis, extensive scarring of the bowel, fibrous stricture, pseudopolypoid and malignant degeneration as well as arthritic changes. Obstruction calls for surgical decompression but when dealing with peritonitis associated with acute perforation, it may be well to employ "watchful waiting" with Ochsnerization, intestinal intubation and especially antibiotic and chemotherapeutic measures.

Our experience has been limited and in no way compares with that indicated by the reports of others. In a series of 227 patients with chronic ulcerative colitis ileostomy was performed in nineteen instances, either as an elective or an emergency procedure and four deaths resulted, a mortality of 21 per cent. There were ten total or partial colectomies without a death. In each case the rectum was removed.

*Diverticulitis.* There is common agreement that a good proportion of patients suffering with diverticulitis will respond to non-surgical management. Also, there is little diversity of opinion that the complications of this disease require surgical intervention. Among these complications peridiverticular abscess, perforation, fistula and obstruction may be mentioned. It is often impossible to distinguish between malignancy and diverticulitis. Therefore, exploration under such circumstances is justifiable.

It is recognized that establishment of a stoma proximal to the involved segment of



bowel is followed by symptomatic improvement which occurs as a result of subsidence of the inflammatory process. This amelioration of symptoms may be temporary and of varying degree. The desire of patients for closure of the colostomy often becomes a troublesome prob-

its concomitant complications must be studied individually since no single procedure can be selected arbitrarily to suit the requirements of every case, the exteriorization operation designed by Mikulicz and modified by Rankin will be found applicable in most cases. During

TABLE II  
SURGERY IN CHRONIC ULCERATIVE COLITIS

Author	Ileostomy	Mortality, Per Cent	Ileosigmoidostomy	Colectomy	Mortality, Per Cent
Cave <sup>15,16,17</sup> .....	65	18.0	11	55	10.9
Cattell <sup>14</sup> .....	145	18.0	..	121	20.8
Garlock <sup>15,20</sup> .....	15	13.3	6	16	18.7
Idem <sup>21</sup> .....	38	15.7	21	46	10.8
Bargen and Pemberton <sup>13</sup> .....	130	26.9	20	30	36.3
McKittrick <sup>26</sup> .....	54	27.7	..	10	10.0
Rankin <sup>18,29</sup> .....	26	31.7	..	..	..
Lemmer <sup>19,25</sup> .....	17	23.5	4	11	18.0
Ferguson <sup>8,19</sup> .....	14	?	..	9	?
Wangensteen <sup>32</sup> .....	..	....	..	13	none
Ault <sup>33</sup> .....	6	16.6	..	13	15.3
Bacon <sup>34</sup> .....	19	21.0	..	12	none

lem and it is frequently difficult to convince them that closure should be postponed. Certainly several months should be permitted to elapse before closure is contemplated. During this period irrigation through a completely inactivated bowel should be instituted and antibiotic and chemotherapeutic measures employed.

Unfortunately no definite criteria exist by which one may determine the precise time when closure should be effected or when there is no danger that recurrence of symptoms will develop. Ordinarily closure may be reasonably safe after the patient has been completely symptom-free during a period of several months and regression of the process with restoration of bowel continuity has been observed by roentgenologic and sigmoidoscopic examination. It is worthy of mention that in Pemberton's series<sup>27</sup> satisfactory relief followed closure of the colostomy in less than one-third of the patients.

Removal of the diseased segment of bowel is indicated when symptoms recur following complete proximal defunctionalization despite the use of sulfonamide and antibiotic therapy. Also resection should be performed when a fistula exists or when malignancy is suspected. While patients with sigmoidal diverticulitis and

the past decade there has been a definite trend toward resection and immediate establishment of continuity. While such an operation alone serves to eliminate much of the invalidism associated with multiple stage procedures, there is seldom an instance in which it can be employed without risk unless defunctionalization has been instituted previously.<sup>6</sup> In our series of 104 patients with diverticulitis thirty-two were subjected to operation.<sup>5</sup> Resection was performed in twenty-one instances. Proximal colostomy of the defunctionalizing type (Wangensteen<sup>31</sup> or Devine<sup>18</sup>) was usually established at a suitable time prior to resection. Six operations were performed by the exteriorization method of Mikulicz, three by abdominoperineal proctosigmoidectomy and six by resection followed by end-to-end anastomosis. Sigmoidectomy with permanent colostomy and extraperitonealization of the closed rectal stump (Hartmann technic) was instituted in six patients. Partial cystectomy was required in four instances. The only death in this group occurred as a result of peritonitis following resection and end-to-end anastomosis.

*Hemicolectomy and Proctosigmoidectomy with Transplantation of the Transverse Colon to the Anus and Preservation of the Anal Sphincter Musculature.* During the past few years we

have examined a number of patients who have refused colostomy or had had a colostomy established either as a part of an abdominoperineal excision or for some other reason. In thirty-three patients we have either anastomosed the colostomy to the extraperitoneal-

TABLE III

Operation	No. Cases	Death	Mortality, Per Cent
Exploration only.....	1	0	0
Colostomy for obstruction.....	5	1	20
Incision and drainage of abscess.....	3	1	33½
Drainage for perforation without closure.....	2	0	0
	11	2	18.1

ized rectal stump which remained following a Hartmann operation or have transplanted the colostomy to the internal anal margin. There were no deaths in this group. An unusual surgical procedure is a left hemicolectomy and proctosigmoidectomy followed by transplantation of the transverse colon to the internal anal margin. Preservation of the anal sphincter muscles is accomplished by this operation which is performed as a one-stage procedure. While limited in its applicability, it has served its purpose well in eleven cases eight of which have been reported previously.<sup>10</sup> The conditions for which the operation was performed included polyposis, extensive diverticulitis with stricture formation, malignancy, ulcerative colitis and malignancy and extensive inflammatory stricture of the rectum and left colon. There were no deaths in the eleven cases. The average period of hospitalization for ten of the eleven patients was 14.2 days; two and a half months was the average time which had elapsed when they returned to work. In no instance was difficulty encountered with viability of the transplanted bowel.<sup>9</sup>

**Endometrioma.** There were three instances of endometrioma of the rectosigmoid diagnosed following operation and are mentioned because of their apparent rarity. Two patients survived proctosigmoidectomy but one developed uterovaginal fistula one year later which was cor-

rected. In the third, resection with end-to-end anastomosis was successfully performed.

**Inflammatory Rectal Stricture.** Our experience with inflammatory stricture, particularly of lymphogranulomatous venereal origin, has been made possible through the facilities

TABLE IV

Type of Resection	No. Cases	Death	Mortality, Per Cent
Exteriorization (Mikulicz).....	6	0	0
Abdominoperineal proctosigmoidectomy.....	2	0	0
Abdominoperineal proctosigmoidectomy with hemicolectomy.....	1	0	0
Resection followed by primary end-to-end anastomosis.....	6	1	16.6
Anterior resection with colostomy and exteriorization of closed rectal stump (partial cystectomy in four).....	6	0	0
	21	1	4.7

offered by three Philadelphia hospitals situated in densely populated colored districts. During the thirteen-year period from 1932 to 1945 11,134 patients with various manifestations of this disease have been examined. Of this number 704 had stricture of the rectum. Ample opportunity was afforded for use of various forms of treatment but even as early as 1938 it was realized that the most satisfactory treatment for rectal stricture was surgical extirpation. Because of the concomitant perirectal infection, a two-stage operation which consisted of colostomy and later perineal excision (Lockhard-Mummery) was found to be the procedure of choice. There were fifty-one of these patients twenty-four of which were reported previously. A loop colostomy was performed in all and the distal loop was irrigated daily. Following a period of three to nine months a perineal excision was performed. Although there was only one death in this group of patients (mortality 1.9 per cent), the morbidity was marked.

Surgical management of inflammatory rectal stricture has become somewhat altered in our hands during the past few years and may be described as follows: In the presence of exten-

sive esthiomene of the anal margin complicated by multiple active abscesses and fistulas the first stage of the treatment is the performance of a double barrel colostomy. Sulfonamides and penicillin are given for the purpose of diminishing the severity of the infection. In some in-

satisfactory. Our experience with the surgical treatment of diverticulitis, chronic ulcerative colitis, endometrioma of the sigmoid, inflammatory stricture and polyposis is described.

TABLE V  
INFLAMMATORY RECTAL STRICTURE

No. Cases.....	704
Colostomy and perineal excision (Lockhart-Mummery).....	51
Mortality (1 death).....	1.9%
Abdominoperineal proctosigmoidectomy....	22
Mortality.....	0

stances roentgen therapy is administered. Later perineal excision is performed.

On the other hand, when esthiomene, abscess and fistula are absent, an abdominoperineal proctosigmoidectomy is performed. In twenty-two patients with rectal stricture we have instituted this technic; and while there has been no fatality, we believe that more complications and sequelae have arisen than we believe should have occurred.<sup>4</sup> It is our opinion that for patients in this category the most satisfactory method is a three-stage maneuver consisting of (1) transversotomy and after a rest period; (2) an abdominoperineal proctosigmoidectomy with preservation of the anal sphincter musculature; (3) extraperitoneal closure of the loop transversotomy.

**Intestinal Polyposis.** Our experience with this disease entity while not large has been sufficient to formulate conclusions as to its surgical management. It is our opinion that with the establishment of the diagnosis of polyposis by sigmoidoscopy and roentgenography employing the double-contrast technic, radical surgical extirpation should be instituted without delay. Several instances of resection, total or partial, have been performed without fatality and with low morbidity. In a few cases proctosigmoidectomy alone or in combination with left hemicolectomy has been instituted with preservation of the anal sphincter musculature.

#### SUMMARY AND CONCLUSIONS

A series of patients suffering with malignancy of the anal canal, rectum and sigmoid colon is discussed in relation to surgical treatment. Evidence is offered to show that mortality following proctosigmoidectomy is low, morbidity is decreased and rate of survival is

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# SELECTION OF PATIENTS AND ANASTOMOTIC PROCEDURES FOR CARCINOMA OF RECTUM AND RECTOSIGMOID\*

R. RUSSELL BEST, M.D.

*Omaha, Nebraska*

IN the progress of surgery, particularly the eradication of malignancy, the pendulum swings from the original procedure which in usually conservative with grave consideration for retaining normal physiology to a more radical procedure with destruction of everything which might possibly be involved. This pattern is followed because the original operation has resulted in too many recurrences of the cancer. Then after improvement in results by the more radical method the pendulum swings again (I omit the word "backward") as now with more detailed knowledge, experience and interim advances in technic and supportive treatment, consideration is again given to physiologic preservation or reconstruction. This pattern has been followed in carcinoma of the rectum and rectosigmoid and at this time many are seriously concerned about preserving the anal sphincter mechanism. This demands more thought and attention to the type of operative procedure selected for the patient because some slight technical change may alter the mortality, morbidity and curability. Also, this has caused us to give more consideration to the type of procedure the patient desires. I believe it is the inherent right of the patient to express his preference for a permanent colostomy or for some type of operative procedure with sphincter preservation providing he has some understanding of the possible smaller percentage of cures without colostomy as well as an appreciation of the disadvantages of the colostomy. This means a different and more difficult psychologic approach for the surgeon because for the moment he cannot speak with the same assurance as to possibilities based on a rather long experience of his own or his colleagues. Again it means more effort technically and from my experience a few more complications. Maybe this is good for us. At least it is not harmful if it is beneficial to the patient.

For forty years we have almost universally accepted the dictum of Miles that carcinoma easily, readily and frequently extends upward, laterally and downward. Little attention was given to analyzing the article by McVay<sup>15</sup> in 1922 when he reported on the involvement of the lymph nodes in one hundred cases of carcinoma of the rectum. Although forty-seven of these cases had metastasis to lymph nodes, in only one case was there involvement of a node below the lower margin of the lesion and this was only at the 1 cm. distance. Since then other important studies have appeared, namely, Wood and Wilkie<sup>22</sup> in 1933, Westhuer<sup>21</sup> in 1934, Gabriel, Dukes and Bussey<sup>11</sup> in 1935, Gilchrist and David<sup>12</sup> in 1938, Collier, Kay and Mae Intyre<sup>8</sup> in 1940 and Grinnell<sup>14</sup> in 1942. These authors reported 507 cases all closely studied for retrograde lymph gland metastasis. Only eight cases revealed involvement of nodes below the lesion. In 1944 Glover and Waugh<sup>13</sup> further substantiated the fact that metastasis at a greater distance than 2 cm. from the lower margin of the lesion was unusual. They analyzed one hundred surgical specimens of advanced carcinoma of the rectosigmoid region. There were thirty-six instances in which a node was involved below the lesion, but in only three were nodes more than 2 cm. below the lesion involved. This study was based on specimens which had been fixed in formalin for a long period of time and one would not expect the results to be quite as reliable. Nevertheless the figures hold up against the apparently more accurate studies of Gilchrist and David, and Grinnell by the modified Spalteholz method. With this additional series we have a total of 607 cases. In only twelve instances (2.3 per cent) the node involved was more than 1 cm. from the lower margin of the lesion and in only five instances (.82 per cent) the node involved was more than 2 cm. from the lower margin of the lesion. (Table 1.) This is of definite

\* From the Department of Surgery, University of Nebraska College of Medicine, Omaha, Neb.

significance since our reports for five-year cures for carcinoma of the rectosigmoid and rectum vary between 45 and 70 per cent. If only .82 per cent of patients have nodes involved more than 2 cm. below the lower margin of the lesion, and if we transect the rectum  $2\frac{1}{2}$  cm. (1 inch) to

colosigmoid tissue to offer opportunity for complete eradication of vulnerable tissue.

Invasion of the venous channels and spread by this means probably occurs more frequently than is usually realized. It is not unusual to see patients who have liver metastasis in addition

TABLE 1

COLLECTED DATA ON INCIDENCE OF LYMPH GLAND INVOLVEMENT BELOW MARGINS OF MALIGNANT LESIONS

Author	Year	Cases Studied	Cases with Nodes (1 to 2 cm. below lesion)	Cases with Nodes (2 cm. or more below lesion)
McVay.....	1922	100	1	0
Wood and Wilkie.....	1933	100	0	0
Westhuer.....	1934	74	1	0
Gabriel, Dukes and Bussey.....	1935	100	2	0
Gilchrist and David.....	1938	25	0	2
Coller, Kay and MacIntyre.....	1940	33	1	0
Grinnell.....	1942	75	1	0
Glover and Waugh.....	1944	100	6	3
Total cases.....	....	607	12	5
Percentage.....	....	....	2.3	.82

5 cm. (2 inches) below the lesion and leave an anorectal stump, there is little reason to fear that we are leaving involved nodes in most cases. Also, many studies on serial section of the rectal wall below the lesion rarely reveal intramural extension below the  $2\frac{1}{2}$  cm. (1 inch) level. However, if we are to keep curability foremost in our minds as well as to try to avoid the permanent abdominal anus, care must be taken to be sufficiently radical in removing adequate sigmoid and mesosigmoid with the most vulnerable gland-bearing tissue. It is my belief that when one has a small rectal stump which can be elevated for the anastomosis, he is less likely to sell short the adequate removal of the sigmoidal or descending colon tissues. Among other reasons at the present time this forces me to choose some type of anastomotic procedure rather than any pull-through operation in most cases.

Lateral spread has been sufficiently proven so that it is not controversial. However, an area at the level of the levator ani muscle and fascia requires additional analysis and will be discussed elsewhere. (Fig. 1.)

The main pathway for extension is upward and we must sacrifice sufficient mesentery and

to a small, invasive type of tumor with or without lymph gland involvement. Gilchrist and David<sup>12</sup> and also Coller<sup>8</sup> reported evidence of vein metastasis as approaching 15 per cent of their cases. Bacon<sup>2</sup> reported 12.9 per cent.

The reconstruction of continuity with attempt at sphincter preservation may be accomplished in two different ways, namely, direct anastomosis between remaining anus or rectum and the sigmoid or colon; or by pulling the sigmoid or colon through anal margin tissues. Many individual technics exist with such variation of details as using or not using a rectal rubber tube to serve as a splint; removing or not removing the coccyx or a segment of the sacrum; anterior or posterior incision or both of the anal sphincter; excision of external or internal sphincter muscle or both; and many methods and types of sutures. In most instances in which the pull-through technic as advocated by Babcock and Bacon employing the Hochenegg principle has been used, the sphincter entity has been disturbed by incision or excision of some part of it. In the relatively few times I have carried out this principle of reconstruction or have had the opportunity to examine patients operated upon

elsewhere I have not been impressed by the degree of radical excision of tissues in the supra-sphincter and levator ani regions or by the appearance or anal security. However, one cannot deny that in an occasional case in which an anastomotic procedure has been accom-

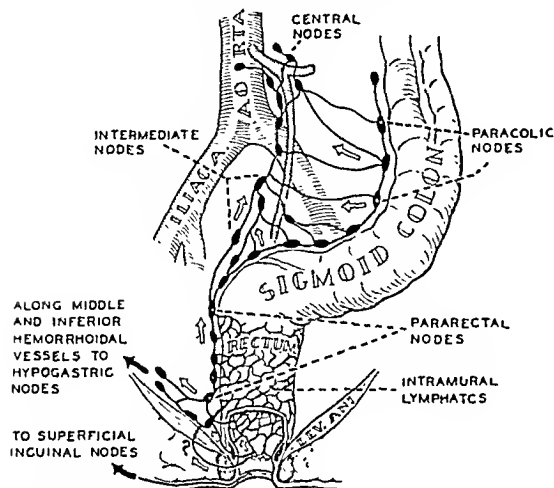


FIG. 1. In the anal canal three modes of spread are considered. The anal skin is drained by lymphatics leading to the superficial inguinal nodes. Above the skin margin is an intermediate area which may drain laterally to the undersurface of the levator ani and recent studies reveal that the pathway through the levator muscle at the site of the question mark does not exist. The lymphatics on the undersurface continue on the undersurface to the lateral pelvic wall. Other channels lead directly upward into intramural lymphatics. The upper anal canal and lower rectum may drain along the upper surface of the levator ani and into the hypogastric nodes or proceed upward along the pararectal nodes. Observations suggest that pararectal and paracolic nodes tend to drain into the intermediate nodes; but if these become blocked, the spread is likely to be directly upward along the paracolic nodes.

plished through a posterior approach the sphincter is not quite the dependable master of the area under all circumstances that it was previous to surgery.

Eradication of rectal carcinoma followed by an anastomotic procedure may be accomplished in three different ways which I have previously described,<sup>4,5</sup> namely, abdominal dissection with abdominal resection and anastomosis; abdominal dissection with posterior resection and anastomosis; and posterior dissection with posterior resection and anastomosis. With the combined abdominal and posterior approach as used for direct anastomosis in some cases, there is more radical excision of the levator ani muscle and fascia than when a pull-through

operation is used. We believe this is very important in lesions involving the 5 to 7½ cm. level, and this statement is based on investigations and study of the lymphatics of the levator ani muscle and fascia over a two-year period. This study is nearly completed and will be reported.

In selecting patients for rectosigmoidectomy and anastomosis it is well to keep in mind those conditions which are primarily antagonistic to safe or satisfactory accomplishment: (1) One should be hesitant about attempting anastomosis and favor the abdominoperineal excision in very obese, heavy set individuals. We are quite confident that an anastomotic operation is more difficult for the surgeon and more trying and exhausting for the patient, particularly the abdominal dissection with abdominal resection and anastomosis. This is more pronounced in the obese patient. The surgeon must have better exposure and more relaxation; and with the time in the abdomen lengthened because of the anastomosis, a more prolonged and deeper anesthesia is necessary. There is less security of the anastomosis line because of the abundant fat and the infective factor is more hazardous. Also, the posterior dissection with posterior resection and anastomosis is usually difficult in this type of patient and, furthermore, this type of procedure is not sufficiently radical. (2) In all poor risk patients one should favor colostomy and posterior excision or even abdominoperineal excision rather than an anastomotic procedure. In some cases simple colostomy, radium or electrocoagulation may be indicated. Possibly the posterior dissection with posterior resection and anastomosis should be recommended in some of these cases when the lesion is 5 to 7½ cm. (2 to 3 inches) from the external margin of the anal sphincter, particularly in those patients in the late seventies or eighties.

Location of the lesion as well as the age and general condition of the patient serve as an indication for which one of the three operations should be applied in the individual case. The abdominal dissection with abdominal resection and anastomosis is usually selected for a lesion of the rectosigmoid and for upper rectal lesions whose lower margin is at least 7½ cm. or more from the external anal margin. With a lesion whose margin is below this approximate level, lateral spread over levator fascia is a possibility and abdominal approach does not permit

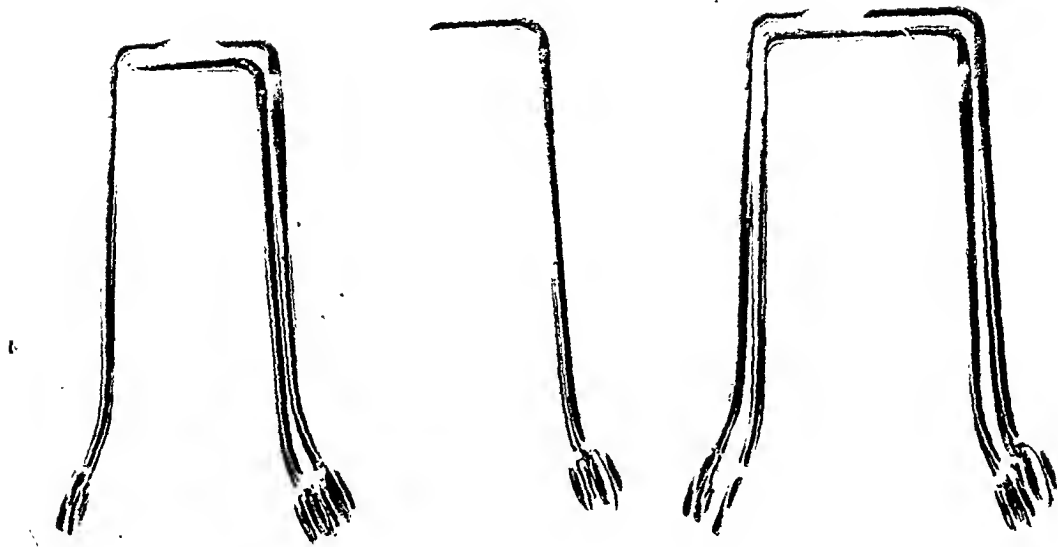


FIG. 2. Set of four clamps which greatly facilitate anastomosis low in the pelvis. The extra clamp is used in case of a very narrow rectum permitting both the lower clamps to grasp the lower segment. In a very wide rectum the clamps may be so applied as to secure complete crushing of the upper segment and leave only a small opening between ends of the lower clamps. (Courtesy of V. Mueller & Company, Chicago.)

adequate removal of the zones of lymphatic spread in the levator muscle and fascia. On several occasions I have anastomosed the rectum by the abdominal route to within 1 inch of the anal canal. However, no surgical procedure should be advocated merely on the grounds that it is technically possible. On nine occasions I<sup>6</sup> have anastomosed the ileum to the lower rectum or anus. The results have been reported elsewhere but they were not very satisfactory and indications for this procedure seem limited to polyposis of the colon with a low lying rectal carcinoma.

The second procedure, abdominal dissection, posterior resection and anastomosis, is recommended when the lower margin of the malignant lesion is below the  $7\frac{1}{2}$  cm. (3 inch) level but yet above the 3 cm. level. Abdominal dissection assures radical removal of the zone of upward spread and the posterior attack permits removal of lateral lymphatic spread in the levator fascia and muscle or direct extension into the levator muscle and fascia. These structures are not adequately removed by an abdominal dissection. (Fig. 1.)

The third procedure, posterior dissection with posterior resection and anastomosis, cannot be considered adequate surgery for cancer of the rectum. It is recommended only under

special circumstances and as an escape from a higher mortality in the aged and a few of the poor risk cases.

We should have some generally accepted standard for measuring the height of these lesions. For reasons of simplicity and accuracy it is suggested that we accept the method of recording the distance from the external margin of the anal sphincter. The average index finger reaches to a height of  $7\frac{1}{2}$  to 8 cm. (3 inches) and the second joint reaches approximately to the 5 cm. (2 inch) level. Certainly the only accurate method of measuring with the scope is to have the end of the scope against the lower margin of the lesion and record the distance from the lesion to the external sphincter margin.

Figures are the only criteria for analysis; and although frequently they seem difficult to appreciate because of detours in methods of determination and correlation, a recent analysis of a small series of thirty-three consecutive cases is reported. Of these thirty-three patients I examined five were considered too far advanced for the possibility of resection. One of these five patients was advised to have and submitted to a colostomy because of impending obstruction. Not including the latter, twenty-eight patients were submitted to operation on



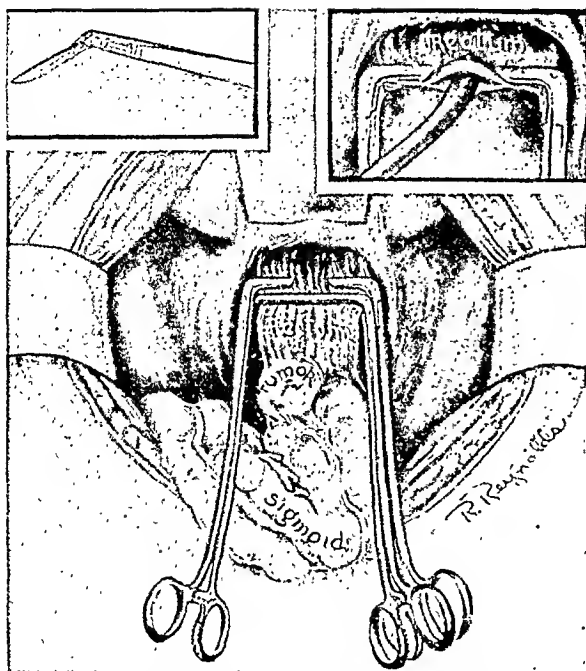


FIG. 3. Rectum dissected free and clamps applied; with angled knife the rectal segment is transected. This should be at least 1 inch below lower margin of lesion and preferably 2 inches. A suction catheter is placed between the ends of the lower clamps and into the rectum.

the possibility that resection could be accomplished. This is an operability rate of 84.8 per cent. Of these twenty-eight cases colostomy alone was done in three instances without mortality. The remaining twenty-five cases were subjected to resection with preservation of the sphincter mechanism or abdominoperineal resection, a resectability rate of 75.7 per cent. In three of these cases an abdominoperineal resection was done without mortality; and in twenty-two cases (88 per cent) intestinal continuity was re-established in the rectum and the sphincter mechanism preserved. It is my opinion at the present time that this figure of 88 per cent is a little too high for the number of cases in which sphincter preservation should be restored. In retrospect and from further experiences it is probable that an abdominoperineal resection should have been done in two of the twenty-two cases which would have resulted in only 80 per cent of the cases submitted to resection having intestinal continuity restored. In like manner it might have reduced the mortality. As it was there were two deaths, a mortality of 8 per cent for the twenty-five cases submitted to curative surgery with or without anastomosis and a 9 per cent mortality

for the group in which an anastomotic procedure was carried out. (Table II.)

We do an open type of anastomosis whether this is accomplished from within the abdomen (Figs. 3, 4, and 5) or by the posterior approach. (Fig. 7.) For the anastomosis done within the

TABLE II  
CARCINOMA OF RECTUM AND RECTOSIGMOID ANALYSIS OF  
THIRTY-THREE CONSECUTIVE CASES

Cases	Operated*	Re-sected*	Anastomosis†	Abdominoperineal‡
Number—33...	28	25	22	3
Per cent. ....	84.8%	75.7%	88%	12%
Mortality				
Deaths. ....		2	2	0
Per cent. ....		8%	9%	

\* Per cent of total cases seen.

† Per cent of resectable cases—too high?

‡ Per cent of resectable cases.

abdomen special clamps have been devised to facilitate the technic when working deep in the pelvis and are depicted in the accompanying drawing. (Fig. 2.) A supplemental cecostomy or appendicostomy of a modified Gibson type (Fig. 6) is done routinely in all cases of abdominal dissection with abdominal resection and anastomosis and in cases of abdominal dissection with posterior resection and anastomosis. In cases with posterior dissection and posterior resection and anastomosis a rectal tube is used rather than a cecostomy. We believe that a cecostomy is just as efficient as the nasogastric or naso-intestinal tube, is much more comfortably for the patient and with any leak at the suture line it serves much better. We have had no difficulty with the cecostomy failing to close immediately after removal of the mushroom catheter.

We drain the retrorectal space in the hollow of the sacrum by the posterior approach in every case. Following removal of this drain we frequently have a draining sinus for some days or weeks and at times feces appear. Two of these posterior draining sinuses although small proved stubborn and annoying for several months.

Incontinence has not been a troublesome factor but it cannot be denied that the sphincter in some cases seems to lack its original energetic tone. This is particularly true when the resec-

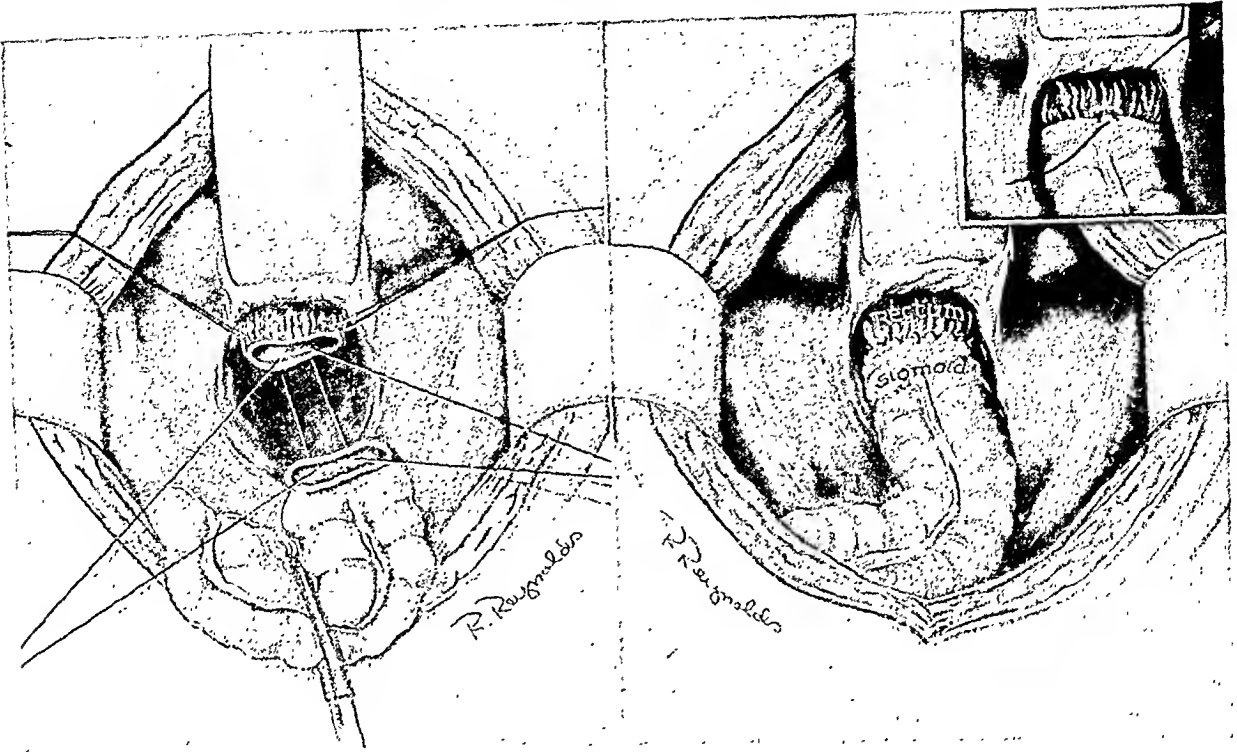


FIG. 4. The short nosed clamps have been replaced by traction sutures. Then five guide sutures are placed on the posterior walls similar to the two already inserted. The knots are on the mucosal side so as to invert the margins firmly. (Courtesy of *Surg., Gynec. & Obst.*, 86: 98-106, 1948.)

FIG. 5. A single layer of interrupted figure-of-eight or mattress silk sutures complete the anastomosis. An attempt is also made to place such sutures on the entire posterior wall so as to support the catgut sutures. (Courtesy of *Surg., Gynec. & Obst.*, 86: 98-106, 1948.)

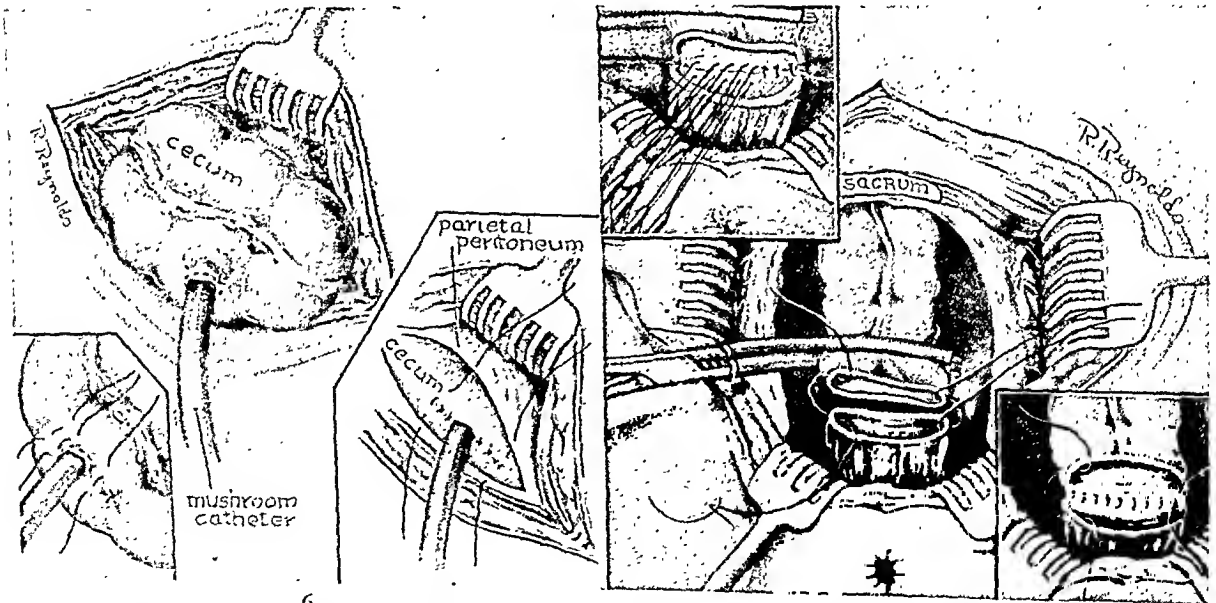


FIG. 6. A supplemental cecostomy by purse-stringing a mushroom catheter into the cecum. The cecal wall is inverted and the cecum fixed to the parietal peritoneum. (Courtesy of *Surg., Gynec. & Obst.*, 86: 98-106, 1948.)

FIG. 7. Posterior anastomosis with inner row of interrupted catgut sutures. To facilitate the procedure all sutures on the anterior wall are inserted and then tied. After tying these sutures a row of inverting interrupted figure-of-eight silk sutures is inserted around the entire rectum. (Courtesy of *Surg., Gynec. & Obst.*, 86: 98-106, 1948.)

tion and anastomosis are done posteriorly in the more feeble individuals in their late seventies or eighties. In two cases we encountered the problem of feces collecting between the sphincter area and the line of anastomosis with the patient unable to expel the feces without an enema. This difficulty lasted for several weeks.

It is impossible at this time to give dependable figures on curability for operations directed toward maintenance of the sphincter mechanism. There have not been a sufficient number of patients operated upon by a sufficient number of surgeons over a long enough time. Excluding those on pull-through operations, all figures on morbidity, mortality and curability are based upon antiquated technique and pre- and postoperative care before the days of what might be termed modern surgery. Three, five and ten years hence one can speak with authority but in the meantime we can attempt to avoid colostomy in selected cases and hope that technical improvements and further anatomie-pathologic knowledge will promote an encouraging report.

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#### DISCUSSION OF PAPERS BY DRS. WOLFE, MCNEALY, BEST, BACON AND VAUGHAN

RAYMOND W. MCNEALY (Chicago, Ill.): The subject of carcinoma of the rectum is so extensive in all of its implications that I shall make no attempt to cover the field.

I make the stipulation first that since we are unacquainted with the cause of carcinoma, we shall make no claims for cure, but simply state what the period of life has been after the operation. We believe that we accomplish our ends when we lengthen the life of the patient.

I like Dr. Best's statement that some of the pull-through operations do not leave the complete mastery of sphincter control that one might desire.

In primary resection with immediate anastomosis, there are several things that have to be there at the time you do the operation. First, you have to have a clean bowel. By that, I mean it has to be free of fecal material. More important probably is the fact that it must be free from

barium which has been given before surgery. In our hospital we keep reiterating the statement that no patient can be brought to the operating room for resection of the large bowel who has not had a fluoroscopic examination on the day before the operation. This is done to be sure that the bowel is free from all foreign material at the time we expect to do an anastomosis of the bowel.

Another stipulation that I think is very important is that when you are going to anastomose the cut ends of a bowel that is as thin as the large bowel and whose circulation is as equivocal as it is in some instances in which you free it rather liberally from its original site, that there be absolutely no trauma to those bowel ends before you anastomose them.

We absolutely prohibit the use of any crushing forceps on any bowel edge that is to be united end-to-end. In other words, if you want to put a soft rubber-covered clamp below or above, all well and good, but on the edges that are going to be sewn you must not clamp those edges before you sew them. If crushed they have to slough off and that sloughing and separation of the dead tissue is certainly a favored site for the beginning of infection along your suture line.

The next point I would want to make is that if you sew the large bowel, be sure that in your sutures you do not strangulate the tissue that you would like to have unite. In other words, too many sutures often mean too many leaks. A few sutures well placed and well disposed around the lumen are much better than a great number placed indiscriminately. Reinforcements of second and third suture lines are likely to cause complete necrosis of the ends that were originally united by the first row. We have more than fifty resections with primary anastomoses in whom only one row of interrupted fine silk sutures are used on the posterior wall and two rows laterally and anteriorly.

As far as the question of doing a proximal appendicostomy or cecostomy is concerned, in none have we used any method of proximal decompression except the indwelling nasal suction. In all cases we have maintained a rectal tube in the rectum so that we have an air vent distally.

We have never placed a drain near or approximating any anastomosis. I would call your attention to that point. It is important not only in bowel surgery but also in all other plastic repairs of viscera. If you want the line of suture to hold and if you want to avoid fistula formation, never place a capillary drain down to the line of suture. If one places a drain down to the line of suture, the capillarity of the gauze or the Penrose or whatever drain you use will "wick" away by capillarity the plastic exudates, which is the best cement medium that we have for uniting the ends. If it is all "wicked" away, you cannot expect other than fistula formation.

December, 1948

Regarding the improvement we have had in large bowel surgery, I think we can predicate it on two essential bases. The first is that we have become acutely conscious of the necessity of having these carcinoma patients in good condition when we operate upon them. By that I mean the best possible condition into which they can be brought. We very seldom have emergency operations on carcinomas of the large bowel, not nearly the number that we formerly had; and when these patients come in, most of them, by suction or by careful manipulation can be decompressed very well. A rather tedious preoperative care is used in all patients. They have the advantage of the blood bank; they have the advantage of bringing their cevitamic acid levels up, and increasing their healing capacity. Their liver tolerance, and water balances are carefully checked.

The second point is that after these patients are in good general physical shape we direct our attention to the use of the biostatins or antibiotics (sulfa drugs, and penicillin). These have made our results far better than they were before. The liquefaction of the stools as well as their lowered bacterial content has made open anastomosis much more secure.

Blind anastomoses and the so-called aseptic anastomoses are rapidly disappearing as we are having better results in cleaning the bowels out and getting them in better shape for anastomosis.

Our results should improve as we improve in the preparation of the patients and as we improve in our technical facilities. Good healthy tissues will grow together very well. They are well immunized by nature and they need little to encourage their union except we must facilitate the action of the normal healing mechanisms of the body.

W. WAYNE BABCOCK (Philadelphia, Pa.): While not evident this morning, it seems to me in the surgery of the large bowel that we often cling to teachings and methods of a past generation which now should be obsolete. Operators still condemn the modern abdominoperineal resection for carcinoma from experience they had with the Hoehenegg or other old perineal or sacral method of resection, none of which are radical, none of which are aseptic, and all of which carry the complications of a suture anastomosis made through the pelvic floor. None of these antique procedures should have a place in the treatment of carcinoma of the rectum or sigmoid. The Hoehenegg operation in which the lower segment of rectum instead of being removed with the attached growth was denuded of mucosa and used as a sheath through which the upper segment was telescoped, was particularly objectionable. These operations gave me as well as others in the early part of the century a great deal of trouble. They taught that a perineal approach could not be sufficiently radical for the proper removal of a carcinoma of the rectum or sigmoid.

They showed the necessity for a free liberation of the rectosigmoid through an abdominal incision, that a suture anastomosis should not be used in the pelvic floor and that the bowel, with its active peristaltic waves, should not be sutured to the skin or any other fixed part. A few years since, Dr. Wangensteen tried some of these old perineal anastomotic resections with modern aseptic controls but had, as would be expected, an undue number of septic sinuses or fistulas. When the opened perineum is closed as at the termination of an abdominoperineal pull-through type of resection, we avoid infection by using only stainless steel sutures and ligatures in the perineum, by omitting all perineal drains, and by leaving 12 cm. of unsutured bowel protruding from the perineum until after primary union has occurred.

If the carcinoma involves the rectosigmoid, the adequate removal of lymphatics and the preservation of an adequate vascular supply to the retained bowel can be attained only by an abdominal exposure. We are indebted to Miles for a great improvement over the perineal types of resection for rectal carcinoma. Many patients have been saved by his more radical type of operation, but he was in error in believing that carcinoma diffused caudad as well as laterally and cephalad; also in thinking that it was important to form a pelvic diaphragm to prevent pelvic adhesions. In 195 per cent of the patients the cancer does not invade the pelvic floor, sphincters or anus which need not be sacrificed. For eighteen years in proctosigmoidectomy we have freely resected the pelvic peritoneum without forming a pelvic diaphragm, with no secondary trouble from pelvic adhesions. There is good evidence that the catgut used in forming the pelvic diaphragm leads to more adhesions than would the denuded pelvis; while peritoneal recurrences after the Miles operation suggest that in retaining a pelvic diaphragm, insufficient peritoneum is removed. Catgut, silk and cotton left in the peritoneum will produce adhesions, but particularly catgut. Peritoneal adhesions do not form over stainless steel wire. We have later reopened a number of our patients left with a denuded pelvis and have found the pelvis practically free from adhesions.

In the closure of the abdominal wound a new security and safety has followed the exclusive use of non-irritating metallic sutures. In 4,000 consecutive abdominal sections, in 2,000 of which some catgut was used in the abdominal closure, there were seven evertments. In the 2,000 in which an all wire technic was used and in all such operations in the last five years, there has been only one evertment.

The abdominoperineal pull-through type of operation with retention of the sphincter that we use is indicated for cancers of the rectum or rectosigmoid that, grossly, are at least 6 cm. above the

anus. The anal opening permits digital palpation of the lower bowel for recurrence, and we direct the patients to return every one or two months during the first year after operation and at longer periods later. From hundreds of such examinations it has been evident that recurrence from unremoved bits of carcinoma left in the pelvic floor is rare. By these examinations less than 1 per cent have shown such a recurrence unless a palliative or inadequate type of resection had been done. These examinations are also valuable in instructing the patient how to maintain an adequate opening as well as how to control his evacuations properly. I think it is wise in the operation to divide the sphincters; otherwise, if not denuded of mucosa, they have contracted on the withdrawn bowel with secondary gangrene that has a tendency to spread into the pelvis and endanger the patient's life. When divided there is more room for hemostasis and for resection of the prostate or other part that may show invasion.

The divided sphincters are not sutured and care is taken that the withdrawn bowel is not in the least constricted and has a good blood supply. By omitting perineal drainage and using all wire sutures and ligatures, at least 95 per cent of the patients have primary union and a thick, strong perineal floor, without any tendency to a perineal hernia.

Of course, for anal carcinoma the pelvic floor must be sacrificed and secondary perineal hernias are fairly common. For these we have transplanted the colostomy to the buttock or posterior upper thigh, with improvement, and recently have used a strong stainless wire mesh embedded in the floor of the pelvis through a hole in the center of which the bowel is brought to the skin. It is of interest that none of these patients has asked for an abdominal colostomy.

Apparently a perineal colostomy without sphincters is less objectionable than an abdominal colostomy, provided the opening is large, not strictured and free of inflammation. For over sixty patients we have either transplanted or otherwise eliminated an abdominal colostomy. A large proportion had a primary Miles operation, yet none has found the perineal colostomy as objectionable as the abdominal colostomy.

Of course, these patients had the more troublesome or less controllable types of abdominal colostomy or found it an impediment to vocation or marriage. Abdominal colostomies vary greatly as to the trouble they cause. Some are easily controlled and may be exhibited on the stage before an admiring medical audience, while others sputter and spatter and refuse to be controlled by irrigations; or while dry most of the time, are such veritable stench bombs of gaseous iniquity that the possessor cannot hold a job.

One woman wrote, "With my abdominal colostomy I had to take all my clothes off whenever I had an irrigation, and when I got through I not only had to take a complete bath, but also wash my hair and wash the entire bathroom.

One patient with a troublesome abdominal colostomy built an arrangement shaped like an elephant's head, which he held against his abdomen during the irrigation and thus prevented the room from being spattered.

It is of interest that gaseous and other uncontrollable abdominal colostomies, when transferred to the perineum, usually lost their major objections, and with a number of degree of control and ability to go about without a protective pad has been attained.

WILLIAM H. DANIEL (Los Angeles, Calif.): Since the main theme of these three papers is the treatment of lesions of the colon and rectum, with or without colostomy, this discussion will be based primarily upon that question. We still believe that the cure of cancer is paramount, regardless of any changes in anatomy that may be somewhat disconcerting to the patient.

Since the advent of sulfa drugs, penicillin and streptomycin, we have favored the resection and anastomosis in lesions of the mobile left colon. The exteriorization procedure of Mikulicz has its place, especially in cases of prolonged obstruction, in which there is a disproportion between the segments of bowel above and below the tumor.

Dr. Wolfe has presented an excellent description of his surgical procedures and preoperative and postoperative management, in which we concur in practically all details.

Dr. Best has presented his reasons for resections and anastomosis in low rectosigmoid and rectal lesions. We are somewhat confused by all the figures, percentages and centimeters upon which he has based his selections for the procedures which advocates for the cure of cancer of the rectum. We are loathe to accept the dictum that retrograde spread is seldom below 2 cm. because in our experience affected tissue has been demonstrated as low as 2 inches. It has been definitely established that the spread of cancer cells in low tumors of the rectum is through the lymphatics of the levator muscles, and the rich venous supply of the lower rectum enhances the remote metastases to the liver and upward. We are not ready to accept the reports of the pathologist that there is no demonstrable cancer spread from specimens submitted to them, because in many instances the patient has died from cancer metastasis when no cancer cells were identified in the surrounding tissues. We are not in a position to comment upon the merits of the perineal anastomosis in good or poor risks because we have not attempted any of these procedures. It is our opinion that the aged and the poor risk should be given the opportunity to live with a

chance of cure with the least hazard. In the aged, in poor risk patients and in those whose life expectancy is short due to metastasis and in whom the tumor is reasonably low, we prefer the colostomy and posterior resection in two stages. We still believe that heat is a detriment to the life of cancer cells, and employ the Percy cautery in all perineal resections wherein the cancer involves the anus and the lower 2 inches of the rectum.

Dr. Bacon has stressed his preference for the removal of cancer of the rectum and rectosigmoid and lesions above by transplanting the sigmoid or colon into the anal muscles in preference to an abdominal colostomy. Late in 1945 we were impressed by his reports, and performed a number of proctosigmoidectomies with preservation of the anal muscles without colostomy.

We selected the cases in which the tumor was at least 3 inches from the anal margin to compensate for any downward spread. For several months we were enthusiastic about our results, until in about one year we were able to palpate metastases in the perineal areas and in the pelvis in several patients. In fourteen months we became discouraged because 33.33 per cent (eight of twenty-four cases) had palpable metastases which were not cured by local or abdominal perineal resections with colostomy.

Five of the twenty-four patients died of primary and secondary metastases to the liver and abdomen which cannot be attributed to the procedure. One surgical death was from a cerebral accident in a hypertensive. Those alive today are satisfied with the perineal colostomy, some using irrigations every second evening. They do not have perfect control and have accidents as do those with an abdominal anus. None has requested the change to an abdominal colostomy. In our experience the hygienic advantage is more psychologic than mechanical.

We have not had an occasion to transplant the transverse colon in the anus, but have in two cases united the transverse colon to the rectosigmoid by end-to-end anastomosis and the Mikulicz procedure. In one case of malignant polypoid disease of the colon, we have anastomosed the cecum to the rectosigmoid following a colectomy of the involved colon. All are alive with cure a possibility.

During the fourteen months in which we performed the twenty-four pull-through procedures we performed thirty-four abdominoperineal resections with only one local metastasis.

We have no apologies or explanations for our high rate of local metastases which is almost twice that of Dr. Bacon's 17.9 per cent. There were no figures stated by Drs. Wolfe or Best of wound metastases by which a comparison could be made.

Procedures without colostomy are ideal for those patients who absolutely refuse the abdominal anus



or for those in whom incurable cancer metastases have been demonstrated

LOUIS J. HIRSCHMAN (Detroit, Mich.): One word about ileotomy for ulcerative colitis. We have had in the last year experience with two cases preparing to do colectomy after ileostomy; one patient nearly died from massive hemorrhage and the other was losing weight rapidly. We got the patient into the hospital, made a complete gastrointestinal examination and found in the two cases very, very far advanced duodenal ulcers. There may be something in the implant of the ileum and other ulcerative lesions of the upper intestinal tract. It has put us on our guard.

In one case if we had done a colectomy, he certainly would have died.

In the treatment of malignancy in aged patients we agree—and not only in aged but in the younger patients—that the advanced technic in preoperative treatment and preparation has greatly lowered our mortality. I believe in aged patients with our better types of preparation we are able to operate in a much higher age level, in other words, the seventies and eighties and even nineties; and I believe also in those cases by doing local resections, because we know that lymphatic spread is very slow in aged people, we can at least operate for comfort and not endanger their lives by trying too radical an operation.

Then again, particularly in aged people, frequently a malignant polyp can be removed through the proctoscope or sigmoidoscope by electrical means, being sure to take a good portion of the base away with it. The patient will live very comfortably and happily without having to undergo any more serious surgical procedures.

We have these patients come back at repeated intervals every six months for examination and in many cases for several years, without a sign of recurrence, and I believe that is a technic that we should add to our armamentarium, particularly in aged people.

E. G. MARTIN (Detroit, Mich.): Through some inadvertance a discussion of electrodesiccation in preparing the rectum for a colectomy in multiple polyposis has been omitted. The importance of conserving the rectum by destroying the polyps therein is an established procedure. Electrodesiccation must not be confused with cauterization or even coagulation. It is more radical and goes further. I use the cutting current at eighty-five to ninety for electrodesiccation and reserve the coagulating current for the destruction of polyps above the peritoneal reflection. Two, three or four radical desiccation treatments may be necessary before the colectomy is done. The technic involves first a lateral anastomosis of the ilium to the lower sigmoid. The cecum is then mobilized easily following the ligation of the blood vessels passing

through the mesentery. Two points should be mentioned: The transverse colon is dissected free from the omentum with blunt scissors; this leaves the mesentery *in situ*. The splenic non-vascular ligament is found by running the finger bluntly along the trough of the dissected colon on the upper side; this is cut and the splenic flexure is then readily mobilized. The descending colon and sigmoid are mobilized down to the site where the anastomosis was made, cut across and closed. This finishes the operation with the exception of peritonealizing all exposed areas possible; along the transverse colon it may be omitted. This is a simpler procedure than an abdominoperineal extirpation of the rectum.

I examined a young woman upon whom we had done a one-stage colectomy three months ago. She had gained 18 pounds and had about four soft stools a day. It was a familial case, there being a brother and sister similarly afflicted.

DR. HARRY E. BACON (Philadelphia, Pa.): I heartily concur with Dr. Wolfe in what he has just said, about adapting the operation to the patient and not the patient to the operation. As Fallis has stated repeatedly, it is the common surgical sin, and that is the reason we believe that it is only proper that one individual operation should not be selected for every type of case.

Several months ago I had the privilege of having Mr. Morgan, of St. Mark's, London, spend a few days with me in Philadelphia, and this is exactly what he said: "Bacon, I don't particularly like the operation that you fellows are doing over here, but, nevertheless, I am frank to admit I have had no experience with it. I have just visited five large cities in the United States and have seen the very best in the surgical world perform the Miles abdominoperineal method of excision, and I am absolutely astonished with the utter lack of radicality. I have not observed the removal of the levators in a single instance."

In other words, I present to you this thought, that independent of the type of operation the individual surgeon may institute, he can be as radical or as conservative as desired.

Dr. Daniel mentioned that he had one case in which invasion was present 2 cm. below the lower margin of the growth. Our residents, Dr. Fleming and Dr. Rowe, a few years ago, with the assistance of the Department of Pathology at Temple University Medical School, examined 146 consecutive bowel specimens following resection and found only one instance in which the cancer had extended to the 6 cm. level.

Regarding the sphincter muscle mechanism, no one will disagree with the fact that sphincter contraction and sphincter incontinence are not synonymous. The degree of anal continence achieved by preserving the anal sphincter muscu-

lature is uniformly satisfactory. These patients do not wear pads, and they do not soil themselves during wakeful or sleeping hours. They are continent because both the three bundles of the external sphincter and the internal sphincter muscle as well have been preserved.

It will be remembered that the defecatory mechanism is derived from two centers, one in the cortex and one in the conus medullaris; but we have been able to show over a period of years that this pulled-down descending colon or upper sigmoid assumes the characteristics of the old ampullary section of the rectum.

Regarding recurrence, you heard what Dr. Babcock has said about his incidence. I can truthfully state, that all our cases of recurrence are based on those that have past the five-year period. There were twenty-seven cases in this group. Four of this number had liver metastasis at the time of operation and so properly should be excluded. Twenty-three patients with recurrence remained, of which twelve were definitely local recurrence. The computed incidence, therefore, is 17.9 per cent.

It should be stated that the incidence as reported by Gilchrist is not 20 per cent, as reported at our meeting last year in Atlantic City, but is 16 per cent.

Wangensteen has recorded an incidence of 14 per cent based on a group under five years.

Dr. Babcock has mentioned his incidence of obstruction. In our group of cases at the present time we have performed 384 cases of proctosigmoidectomy for cancer and thirty-two for allied conditions, a total of 416 cases. To the best of my knowledge I can truthfully state that we have had only five instances of obstruction as a result of the small bowel descending into the presacral space and of that number one was fatal.

Regarding fistula and what Dr. Best has said, we have had in this group of cases one persistent presacral fistula.

Regarding ileo-anal anastomosis, I personally have had no experience whatsoever. Ravitz, of Baltimore, has done some very excellent work and it has been satisfactory, apparently on dogs.

A few months ago in Minnesota I talked with Dr. Wangenstein and he reported that he had had two cases. One he had to return to the abdomen because of the unsatisfactory condition of the perianal skin. The second, he contemplates returning to the abdomen.

Dr. Babcock did not mention, but I think it is correct that he has had two cases, both for ulcerative colitis. In each, replacement to the abdomen was found necessary.

R. RUSSELL BEST (closing): Dr. McNealy mentioned the crushing of tissue produced by the clamps which I use. This is a technical factor that we have considered very seriously and we have

overcome it by making very sure that we place our sutures about a  $\frac{1}{4}$  inch below the demarcation of the lower margin of our clamp. We do not worry because this bowel is turned to the inside and sloughs into the lumen of the bowel.

Dr. McNealy brought out another point which I think is very important, and I have learned the hard way. That is, not to clean off the fat tabs at the margin of bowel to be anastomosed. There will be fewer breakdowns in the suture line if you utilize these redundant tabs to support the sutures. They do create a crude appearing suture line but it is more secure. If the fat is left and is sort of thrown together in big bites, the results are better.

About the drainage, it is an old axiom in surgery that we do not place a drain on a suture line; but it is true that we must frequently drain such an area, and in placing the drain in the hollow of the sacrum, we make sure that it is below the suture line. We believe that the principle of drainage still holds good where potential leakage must be considered.

How low down should we do an anastomosis in order to leave the sphincter? I am not sure about the answer. It was interesting to read the report of Murray of Toronto, Canada. He reported five cases of posterior resection, to which I cannot agree in the first place, but he resected the lesion when it was within half a centimeter or a centimeter from the sphincter muscle. I do not believe I can subscribe to that type of anastomosis or even to the pull-through procedure. I do not believe Dr. Bacon is advocating sphincter preservation at this low level.

Dr. McNealy and I were discussing the question of vascular spread. There have been several papers recently—I believe one by Gilchrist and David, and another by Carr, Mackey and McIntyre—in which they state they have proved vascular metastasis in about 15 per cent of the cases. That is very important in the analysis of selection of operation for sphincter preservation. It even lends support to the argument for preservation of the sphincter mechanism.

We owe a lot to Dr. Babcock and Dr. Bacon whether we agree with their procedure or not. Their contributions have stimulated us to restoration of the bowel continuity or preservation of the sphincter mechanism, whichever you wish to call it, and out of this something will undoubtedly come in the next five to ten years, whether acceptance of some type of anastomosis or pull-through, I do not know. I am on the fence on that at present but am leaning quite strongly toward the anastomosis in practice.

I cannot agree with Dr. Babcock on the perineal colostomy. I am sure you heard the debate on Communism between Stassen and Dewey; I agree with Dewey that if you have a rascal and do not



have control of him, you should get him out in the open. My belief is the same about colostomies; get them out on the abdomen where you can see them.

Dr. Daniel brought out some of the pertinent and controversial points nicely. That is what this organization is for, to present material and discuss it freely. I disagree with my good friend, Dr. Daniel, however, as to worrying about metastasis below the level of the lesion. I believe that question is fairly well settled by the analysis of the 607 cases gathered from the literature which were studied in a careful and thorough manner. In this group only twelve cases (2.3 per cent) had gland metastasis lower than 1 cm. below the lesion. Only 0.8 per cent of these cases had metastasis at the 2 cm. level or lower. These are important figures as balanced against a recurrence rate of 45 to 70 per cent.

When you do have a metastatic nodule or mass more than 2 cm. below the margin of the lesion or at the 2 cm. level, I believe quite definitely that the lymphatics and glands above the lesion have been blocked if we accept our present understanding of the physiology of the lymphatic system. The tumor cells have gone downward because they have not been able to take the upper channel, and I wonder how many of such cases could be cured by any procedure in which there is this degree of block in the lymphatic channels or glands.

In the studies which we are carrying on and are about to publish on the lymphatics of the levator ani muscle, the fascias of the upper and under-surfaces of the levator ani muscle, we believe we will prove the necessity of excising more of the levator ani muscle and fascia than we have in the past in order to keep our curability rates up with some type of sphincter preservation operation.



# POLYPOSIS OF THE COLON IN CHILDREN\*

JACK G. KERR, M.D.

Dallas, Texas

IN children when bleeding from the bowel is the presenting symptom, the source of the blood is more likely to be an adenomatous polyp of the rectum or colon than any other single lesion. If bleeding is the only symptom, a polyp will be found more often than the combined lesions of these organs that would be expected to bleed.

Polyps are usually mentioned as a possible source of blood in articles which deal with the subject of blood in the stools of infants and children. Discussions which enumerate the clinical types of polypoid disease of the colon and rectum usually omit the childhood variety. Polyps of the colon which occur in children should be included in any discussion of the discrete type of polypoid disease. The condition occurs with moderate frequency and complicating conditions are often superimposed.

Reports in the literature have dealt frequently with polypoid disease of the large bowel in adults. Probably two clinical types will include all cases of polypoid disease mentioned in these reports. These types are (1) multiple polyposis of the familial type and (2) polypoid disease in which one or very few polyps are found. Cripps described "disseminated polyposis of the large bowel" in which a hereditary basis was evident.<sup>1</sup> Erdmann and Morris<sup>2</sup> classified this group as congenital or adolescent in type and those cases in which no hereditary predisposition existed they designated as acquired or adult types. This latter group, frequently referred to as discrete polyposis, has been observed most frequently. The incidence, symptoms, distribution and malignant potentialities of single polyps in adults are well known and opinion regarding them is generally unified. Considerable variation of opinion exists regarding their etiology, however. Several authors have expressed the opinion that they are true tumors.<sup>1,3,4</sup>

In order that some of the clinical and pathologic features of the disease as it appears in children might be correlated and compared with the discrete type of polypoid disease as it

occurs in adults a review of our records of children examined during recent years was made. The group of children comprising this study consisted of one hundred consecutive patients in whom one or more adenomatous polyps or lesions arising from them were found in either the rectum, colon or in both. While no data are available from our records to indicate the incidence of colonic or rectal polyps in general childhood population, knowledge of the frequency with which they occur in children who present symptoms referable to the colon or rectum may be gained from the following statistics: A total of 349 children including those with polyps was examined. In 106 examination revealed no abnormal findings although in nineteen a polyp was strongly suspected because of the history. Anal fissure, anal ulcer or a para-anal abrasion was found in fifty-nine instances; congenital deformities in twenty-seven; prolapse of the rectum in twenty-four; abscess or fistula in twenty and an ulcerative process which involved the mucosa of the rectum or rectum and sigmoid was observed in thirteen. Of the 349 patients there were one hundred in whom polyps were discovered and the single symptom common to all was the painless passage of blood-streaked mucus from the bowel. In many patients this was the only symptom. If a fissure was present, some sign of discomfort was usually observed by the mother of the patient. This statement is mentioned because of the frequency with which parents are told by physicians that rectal bleeding although painless may be owing to the existence of a fissure.

As a rule bleeding from a polyp occurs intermittently and weeks may intervene between episodes. In this group the history of bleeding covered periods from a few days to several years. The average duration of symptoms appears to be of no great significance in this series because a surprisingly large number of children had bled for well over a year while mothers were assured frequently that this sign probably was of no significance. It was fre-

\* From The Department of Proctology, Southwestern Medical College, Dallas, Tex.

quently the anxiety of the mothers that led to adequate, early examination of their children. The passage of small clots of blood occurs frequently. Blood in an amount sufficient to cause alarm occurred in a few instances. The source of these hemorrhages usually was the pedicle stump of a polyp from which all or a large portion of the body of the polyp had sloughed away. Self amputation occurs frequently in children but rarely in adults. It occurred in eighteen patients of this group. It is not unusual for a mother to find polyps which have been extruded through the anus of a child.

In sixty-eight patients a single polyp was found and thirty-two patients had more than one. Usually there were only two or three when multiple polyps existed and in only one patient resemblance to hereditary polyposis was observed. This patient was a three year old boy who had ten or twelve polyps in the terminal 25 cm. of his colon which varied in size up to  $\frac{1}{2}$  cm. in diameter. Throughout this area there were also numerous areas of thickened mucosa which presented the gross appearance of hyperplasia. X-ray examination of his colon revealed a polyp 1 cm. in diameter in the transverse colon and several small polyps in the cecum. This child's father had undergone right colectomy for carcinoma when he was thirty-four years of age.

Ninety-eight of this group of one hundred patients with polyps were eleven years of age or younger. One patient was twelve years of age and one was twenty-four and were included because of significant histories. The average age including the two oldest patients was 3.4 years. Ninety-four patients were five years of age or younger. The youngest child in whom a polyp was found was nine months old. There were fifty-six boys and forty-four girls in the group. Symptoms other than the passage of bloody mucus were, in the order of their frequency: protrusion of the polyp in 28 per cent; diarrhea in 19 per cent and abdominal cramps in 18 per cent.

Protrusion of polyps situated near the anal outlet is not an unusual complication but in several patients of this series protrusion occurred when the polyp was situated 10 or 12 cm. above the anal outlet. In one four year old child protrusion with intussusception occurred and it was found that the polyp was attached 25 cm. above the anal outlet. In

children, prolapse of the rectum can usually be differentiated from protrusion of a polyp by the history and the dark, port wine color of the protruded polyp is easily distinguished from the familiar color and configuration of rectal prolapse.

True diarrhea is not an uncommon symptom when a polyp is present. In a few instances in this series oral medication was administered over long periods of time in an effort to allay the stool frequency. The proximity of the polyp to the anal outlet as well as the frequency with which large doses of mineral oil preparations were given with the intent of checking the bleeding by softening the stool, make the evaluation of this symptom possess doubtful significance.

Abdominal cramps varied in intensity with the size of the polyp and its location. Cramps were severe in three cases and affected the lower portion of the abdomen. Every child who had a polyp situated 25 cm. or higher above the anal outlet complained of this symptom and usually discomfort was severe.

In thirteen patients one or more polyps were present which could not be visualized through a proctoscope 25 cm. in length and were diagnosed by roentgenographic examination of the colon. Eight of these also had one or more polyps which could be visualized on proctosigmoidoscopy. The diagnosis of polyps of the colon and rectum depends upon an adequate examination which includes proctosigmoidoscopy and roentgenographic examination of the colon. Frequently each of these procedures must be repeated. This is particularly true of examination by roentgenography. However, if symptoms are significant, one should never fail to repeat these examinations. If the painless passage of bloody mucus persists, the physician should assume that a polyp is present until he can prove otherwise. One negative examination is not necessarily conclusive. One child in this group continued to pass blood-tinged mucus after two polyps had been removed from the rectum and lower portion of the sigmoid. Another polyp was found in the descending colon on the fourth x-ray examination of the colon. Careful preparation of the bowel is essential prior to each examination. Poor preparation can defeat the purpose of the examination.

In this group of one hundred cases each of the following serious complications was en-

countered one or more times: severe bleeding, anemia, obstruction, intussusception and carcinoma. Definite indication exists, therefore, for the removal of these lesions when found and this dictum applies to those polyps beyond the reach of the proctoscope as well as those which can be visualized through that instrument. Removal may be accomplished by electrofulguration when polyps lie within the terminal 25 cm. of the colon and by colotomy when above that segment of the large bowel.

In children these lesions are adenomatous and on microscopic examination present a gland pattern which always seems to be well preserved and appears like normal colon mucosa. Goblet cells are very numerous and cell nuclei are small. In adults about one-half of the polyps have the same appearance on section as those in children. The others have fewer goblet cells; nuclei tend to be larger and gland reproduction is not accomplished as well. In a certain few definite anaplastic changes are present in the epithelium but no invasion is present. An inflammatory reaction may be present in either the childhood or adult type of polyp but there is no evidence that either lesion if it is a true adenoma is dependent upon this reaction for its origin. That they are true neoplasms and not the result of a localized or diffuse inflammatory reaction seems to be a logical conclusion.

Although we do not have reason to believe that the tendency for malignant change to occur in polyps of childhood is as great as it is in those of adults, one cannot dismiss this possibility. Two patients in this group, with untreated polyps, developed malignant lesions at an early age and from the history of each patient little doubt can exist that the cancer was superimposed upon a polyp of long-standing. One of these patients, a twenty-four year old male, gave the following history: Since he could remember, a mass which frequently bled protruded from his rectum following each defecation. Six months prior to his first consultation regarding this condition the protrusion stopped although bleeding had continued. Examination revealed a lesion of the anterior rectal wall which was 3 cm. in diameter and its lower border was 2 cm. above the mucocutaneous junction. Biopsy revealed a grade II mucoid adenocarcinoma. A one-stage abdominoperineal resection was performed and regional lymph nodes were found to be in-

involved. The patient lived approximately eighteen months following the operation.

The other patient, a twelve year old boy, was admitted to the hospital suffering from partial obstruction of the large bowel. Similar attacks had recurred at intervals during several months prior to his admission. An appendectomy had been performed previously during one attack. When seen on this last admission, the obstruction prevented a thin suspension of barium which had been injected into the rectum from passing proximal to the sigmoid lesion. His past history revealed that since the age of three or four bloody mucus had been passed repeatedly and that lower abdominal, cramping pains occurred frequently. In ten days under a medical regimen his obstructive symptoms were relieved sufficiently to permit an operation which was directed to the obstructing lesion rather than proximal to it. Perforation of the lesion and firm fixation to the left side of the parietal peritoneum had occurred and metastasis had extended to the regional lymph nodes and liver. As a palliative procedure the lesion was freed from the abdominal wall and a modified Mikulicz procedure was performed. The patient lived approximately ten months.

#### SUMMARY AND CONCLUSIONS

Bleeding from the bowel in children strongly suggests the presence of an adenomatous polyp. During the earlier years these polyps are usually of the non-familial discrete type.

The examination of 349 children presenting bowel symptoms disclosed the presence of one or more polyps in one hundred instances. The painless passage of blood-tinged mucus was the single symptom common to this group.

Protrusion of the tumor from the anus does not determine accurately the height of its attachment.

The diagnosis depends upon adequate examination which includes proctoscopic examination and repeated roentgen ray studies when necessary.

The possibility of malignant degeneration and of other serious complications including anemia, obstruction and intussusception constitutes a definite indication for removal of the lesions.

Removal may be accomplished by fulguration if the lesion is situated within 25 cm. of the

anal outlet and by colotomy if it is above that level.

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#### DISCUSSION

ROBERT TURELL (New York, N. Y.): It is both a privilege and a pleasure to discuss Dr. Kerr's paper, dealing with one hundred instances of colonic polyps in juveniles, of which only one may have been of the hereditary type of polyposis. The finding of colonic polyps in 100 out of 349 children who presented intestinal symptoms is considerably higher than the one I obtained in a comparable series of adults.

Dr. Kerr's high yield of polyps in juveniles raises two pertinent questions: (1) The possibility of spontaneous regression or sloughing of colonic polyps in children and (2) the possibility of the existence of some specific causative factors in the Dallas series, future search for which may well shed some light on the formation of polyps in general.

Bleeding, as emphasized, is an important symptom, while protrusion is a significant sign. Protruding polyps may originate a long distance from the anal outlet. These either protrude by virtue of their long pedicle or because of the spontaneously reducible prolapse or even intussusception of the sigmoid into the rectum. The foregoing also holds true for digitally palpable but non-protruding polyps.

The fact that thirty-two of Kerr's patients had more than one polyp imposes an obligation upon us to search for additional polyps whenever one is discovered. The search includes proctosigmoidoscopy and repeated roentgenographic examinations.

As emphasized, polyps may undergo non-invasive and/or invasive malignant degeneration. I have encountered sessile polypoid lesions the centers of which were the seat of an invasive adenocarcinoma that was flanked on each side by histologically proved benign adenomatous polypoid tissue. These are perfect examples of adenocarcinoma developing in a benign adenoma.

As indicated, polyps that are situated within the terminal 25 cm. of the colon may be eradicated by surgical diathermy. The long-pedicle variety may be removed safely by means of an electrosurgical snare. Medium- or large-sized sessile or short-

pedicled adenomas that cannot be looped safely by a snare wire may be removed expeditiously and effectively by means of a double-loop electrosurgical resector.

Of course, polypoid lesions situated above the reach of the sigmoidoscope are removed transabdominally by appropriate surgical procedures.

J. MILTON STOCKMAN (Knoxville, Tenn.): There are some very interesting ideas given us by Dr. Kerr's paper. First, in this series of one hundred cases of polyps in children, he reports two who developed carcinoma following a definite polyp history. The occurrence of these carcinomas took us into the third decade of life. In checking over the percentage of carcinomas in this region we find that roughly 4 per cent of those discovered occurred within the first thirty years of life. It makes us wonder if, by early diagnosis and eradication of these growths, we may not hope to reduce carcinoma markedly in this age group. It is very true that all polyps do not undergo malignant changes but we know that carcinoma in the young is very rapid and the chances of prolonged survival are very poor.

I would like to emphasize the ease of diagnosing a majority of these polyps in children. Fully 70 per cent occur near the rectosigmoidal juncture. The lower bowel of the child is more mobile than that of the adult and, due to the shallow buttocks, one is able to palpate well beyond the valves. The type that we usually find is a true adenoma and quite easily felt, whereas the papillomatous type rarely occurs in children. These are the spongy, soft tumors that are difficult to feel (Binkley). The squatting position facilitates palpability over an even higher area, and with straining enables those situated higher on long pedicles to descend.

Dr. Kerr has emphasized that each patient gave a history of painless bleeding and I do not think that we can say this too often. We like to think of blood streaking of the stool as a diagnostic sign while blood-streaked mucus is a suggestive sign.

In our experience we seem to meet prolapsing of the rectum complicated by a polyp more frequently than in this report. Schwartz, Goldberger and Crockett state that a polyp is "frequently the etiology of the prolapsing of the rectum." Our ratio is approximately one to three, and we never instigate treatment of this condition until we are relatively sure there is not a complicating polyp.

In our opinion this paper is a distinct contribution to the series that has been presented to this society over a period of years and should make us more cognizant of the occurrence of polyps in all age groups and urge us on toward early removal. Although on several occasions the parents have come in with evidence to show that the polyp has sloughed and a perfectly good operation has been ruined, I believe that we should check these areas

at the time for a possible bleeding or incomplete slough, and recheck every six months for either additional polyps, as advocated by W. J. Martin, or the recurrence, as suspected by Swinton and proved by the rare pyogenic polyp as reported by Tom Smith.

In conclusion, may I say that throughout this discussion, I wish in no way to minimize the use of the sigmoidoscope and x-ray studies as diagnostic aids.

JACK G. KERR (closing): I appreciate the discussion of Dr. Turell and Dr. Stockman. I agree with them that a considerable number of these lesions will slough from their attachment and be extruded. I think this happened in approximately nineteen of the patients studied in this group. Frequently this is the explanation for the single episode of melena that occurs in children who have had no previous symptoms referable to the colon. A significant amount of blood may be passed and concrete evidence of a polyp having sloughed may be furnished by the mother who has recovered the tumor following its expulsion.

Dr. Stockman mentioned that, if possible to

reach it by sigmoidoscopy, the area from which the polyp sloughed should be examined. I think this precaution is important: first, because the pedicle may continue to bleed and, secondly, the adenomatous tissue may not separate completely and the small remaining nidus will be responsible for a recurrence of the polyp. Light fulguration of the area usually controls either situation.

One other thought about the diagnostic use in children of a barium enema: It is of practical value that the enema follow rather than precede the removal of all polyps visualized through the sigmoidoscope. Should a polyp be found by x-ray methods after those in the distal 25 cm. of the bowel have been removed, it is immediately apparent that laparotomy will be necessary for its removal.

The routine use of a barium enema in each patient immediately following removal of all polyps in the distal 25 cm. of the colon is perhaps not mandatory as once considered. If polyps are present, symptoms will be observed if the mother is properly and adequately instructed. In only those patients whose symptoms continue are barium enema studies advised.



# TREATMENT OF HEMORRHOIDS

G. JOHNSON HAMILTON, M.D.

*New York, New York*

LYNCH and I have long believed that many hemorrhoids were being excised which might be better treated by sclerosis or palliative measures. To test this hypothesis it was decided to study the records of a large enough group of consecutive cases of internal hemorrhoids seen in our private practice to shed some light on the following points: (1) the end result of hemorrhoids treated by the three methods mentioned heretofore; (2) the symptoms which brought the patient to the doctor; (3) the associated pathologic disorders both local and general; (4) the complications which resulted from the treatment whether postoperative, post-injection or palliative; (5) an evaluation of a combination of methods.

For the purpose of this investigation it was decided to consider only internal hemorrhoids which are definite varices of the superior hemorrhoidal vessels; and that where these masses were confluent, they would nevertheless be described as made up of their component major vessels. Thus, a hemorrhoidal mass extending from one through five o'clock would be considered as three individual hemorrhoids arising at one, three and five o'clock, twelve o'clock being anterior. Secondly it was agreed that their etiology should be accepted as follows: Some degree of stasis is prone to occur in the long column of blood extending from the rectum to the liver especially since these veins have no valves. This leads to a local rise in venous pressure with increased carbon dioxide and decreased oxygen content. This together with the sluggish removal of toxins tends to injure the walls of the veins. Continuation of this condition leads to the replacement of the intima and muscle cells by fibrous tissue. The occurrence of any great stress or strain or even a persistence of lesser strain causes these weakened walls to become stretched and tortuous. As the insults are continued the walls become thickened and the lumen relatively small.

If this hypothesis is accepted, it is obvious that anything which increases the local venous pressure will tend toward the production of a

hemorrhoid. Furthermore this increase in local pressure may be due to a general condition such as cardiac insufficiency, hepatic congestion or to a local condition such as pressure from a mass in the pelvis including a pregnant uterus. Also, it is obvious that to the delayed elimination of toxins and products of metabolism may be added the presence of unusual quantities of either due to systemic diseases. In like manner it is obvious that poor grade veins will succumb to less trauma than would damage normal ones. Hence the diathesis toward the formation of hemorrhoids may follow the mendelian laws.

It was decided that local and general disorders should be eliminated as far as possible before deciding upon the treatment of hemorrhoids. The rules laid down for the treatment of hemorrhoids were as follows: Those hemorrhoids which were sufficiently thick-walled to be palpable were to be treated by excision. Hemorrhoids which were impalpable but visible and produced symptoms were to be treated by sclerosing therapy. Those which were impalpable and asymptomatic although visible were to be treated palliatively. Needless to say certain hemorrhoids which should have been excised were first injected to control bleeding until a convenient time for operation arrived.

To find 100 patients treated by sclerosing therapy it was necessary to study the charts of 278 consecutive patients in whom 951 individual hemorrhoids were described. The remainder of this series was made up of 111 patients who submitted to operation and sixty-seven who were seen in consultation only.

## FINDINGS

*Symptoms.* Bleeding brought 181 of these patients to our office. It was the sole complaint in fifty-one cases and in none of these was there any associated local disorder. Prolapse was the major symptom in 108 patients and was associated with painless bleeding in fifty-four cases; 107 patients complained of pain. Pruritus ani was the sole symptom in two cases and was mentioned by seven other patients as one of

several complaints. However, changes in the perianal skin similar to those observed in patients who suffer with pruritis ani were seen frequently.

*Additional Local Conditions.* Fissures were present in ninety-one cases, thrombosis in twenty-eight, hypertrophied papillae in twenty-six, inflamed or torn crypts in seventeen, fistula in ten and adenomas in nine. It is interesting to note that all of the adenomas were asymptomatic.

#### SURGERY

The technic employed in these cases was simple ligation and excision of the involved superior hemorrhoidal vessels and then the inferior hemorrhoidal vessels if necessary. Plain No. 1 catgut on a small curved needle and small hemostats were used. Every effort was expended to avoid traumatizing tissue. The patients were prepared by several daily corn starch enemas before admission to the hospital. No enema was administered within twenty-four hours of operation. A general diet was permitted. With the patient in the left Sims or lithotomy positions the operative area was cleaned with 10 per cent tannic acid in alcohol. Whenever there was no severe infection, the area was infiltrated with  $\frac{1}{2}$  per cent novocain and this was followed by the injection of 10 cc. of anucaine. This procedure was followed in seventy-eight cases.

Like all oil soluble anesthetics anucaine must be injected with considerable care to avoid pooling and a resultant pressure necrosis. It is used by us only to prevent postoperative pain and, therefore, only in those cases in which none of the fibers of the sphincter are divided since the effect of the anesthetic is produced by preventing spasm of the anal sphincters.

During the war more than 4,867 operations on my service was performed under sodium pentothal anesthesia. I was greatly impressed with the value of this anesthetic and its safety but I believed that a competent anesthetist should always be in attendance and should be prepared to insert an endotracheal tube if necessary. In this large series of cases no complication considered worthy to record was encountered. Laryngeal spasm is of minor significance provided that an anesthetist is competent and properly equipped. Therefore, I have not used local anesthesia since my return

although I still use anucaine for the prevention of postoperative pain.

Upon return to the bedroom the patient should be urged to urinate before falling asleep. It is our belief that much postoperative retention of urine is due to the fact that the patient falls asleep in a semi-drugged state and does not appreciate the desire to micturate until the bladder is overdistended. The patient should be informed that ample sedatives have been ordered but will be given only if requested; that the diet is unrestricted and that bathroom privileges are permitted. Patients are invited to smoke and have a highball if they desire. In fact, 10 gr. of aspirin and 2 ounces of whiskey are frequently more efficacious than  $\frac{1}{4}$  gr. of morphine.

#### COMPLICATIONS

In this series of 111 cases one patient failed to void at the end of twelve hours and was catheterized once. Hemorrhage never occurred. Three patients developed abscesses of the posterior triangular space. It is interesting to speculate as to their cause. The first developed two weeks after the patient's discharge from the hospital and two days after she had slipped while attempting to adjust a window shade and severely contused the perineum. The second patient presented himself because of an external thrombotic hemorrhoid situated at five o'clock and I am by no means sure that the abscess was not present and missed although an error in the injection technic cannot be excluded as a causative factor. The third abscess was in relation to an undiagnosed fistula at six o'clock which was considered even at operation to be merely a fissure. However, when the abscess did appear and was incised, the thick fibrotic tract of the fistula was readily palpable and must have existed long before the operation.

In two instances the hemorrhoidal stump failed to slough because the ligature was only tight enough to prevent hemorrhage. Both stumps were destroyed by fulguration in the office and the procedure was accomplished painlessly without anesthesia.

#### SCLEROSING THERAPY

Many technics have been advocated for the injection treatment of hemorrhoids and many of them have produced admirable results in the hands of their advocates. We do not propose to



urge anyone to adopt our method provided theirs is giving satisfactory results. The technique we utilize is as follows:

The patient is placed in the Hanes position and a Tuttle proctoscope is inserted. This is a

interfere with the operator. The site of injection is cleansed with 10 per cent tannic acid in alcohol and the injection is made with a 3 cc. Luer Lok syringe fitted with a No. 19 gauge needle  $4\frac{3}{4}$  inches long and filled with a 5 per

TABLE I  
OBSERVED MORE THAN FIVE YEARS

Case No.	Complaints	Hemorrhoids Diagnosed	Additional Local Disorders	Contributing Factors	Hemorrhoids Excised	Hemorrhoids Injected	Injections per Hemorrhoid	No. Visits	Date Last Examined	Years Since End of Treatment	Complications
5549	Pain	1	Fissure	0	1	n	n	10	1/12/48	10	
5564	Blind, dizzy	1	0	Neurosyphilosis	0	1	1	1	12/20/47	7	
5581	Bleeding	2	0	0	0	2	2	4	3/16/42	7	
5613	Prolapse, bleeding	2	0	0	2	0	0	0	12/30/47	11½	
5617	Pain	3	Fissure	0	2	0	0	11	12/21/47	12	
5631	Pain, prolapse	3	Fistula, fissure	0	1	0	n	18	2/20/46	10	
5663	Prolapse, bleeding	4	0	0	0	1	1	120	5/7/47	11	Refuses operation
5671	Pain, bleeding	4	Fissure	Constipation	4	0	0	22	10/2/47	10	
5673	Prolapse, bleeding	5	Crypt	Epithelioma	0	0	0	5	5/14/43	5	
5695B	Bleeding	2	4 Papilla	0	0	2	1	4	8/6/47	10	
5735	Bleeding	3	0	0	3	1	1	9	11/13/46	10	New pile
						1 mo. later					
5751	Bleeding	2	0	0	2	0	0	8	6/6/46	9	
5766	Prolapse	3	Fissure	0	3	0	0	12	11/8/46	9	
5778	Pain	3	Polyp, fissure	0	0	1	1	1	12/12/47	10	
5786	Pain	4	Fissure	0	4	0	0	20	12/15/47	10½	Mucosal stricture—relieved by one massage
5794	Prolapse, bleeding	4	Fissure	0	4	0	0	18	9/22/47	9½	
5806	Bleeding, prolapse	4	0	0	3	0	0	12	1/10/48	10	
5810	Bleeding	4	0	0	2	0	0	13	9/26/47	10	
5818	Pain, bleeding	3	Fissure	0	2	0	0	14	9/10/47	10	
5921	Prolapse	5	0	0	0	4	4 × 1 (failed) 1 × 3	12	10/18/46	7½	Refused operation
5983	Pain, bleeding	5	Fissure	0	2	0	0	10	3/17/47	6	
6043	Pain	5	Fissure	0	0	2	1	21	9/13/46	7	Refused operation
7002	Bleeding	4	Papillas	0	0	3	2 × 1 1 × 1 (1 failed)	8	3/14/47	7	Refused operation
7126	Pain, bleeding	3	Fissure	0	0	2	1	5	3/26/42	5	Refused operation
7139	Bleeding	3	Adenoma, fissure	0	3	0	0	15	2/24/47	7	
7159	Prolapse, bleeding, pain	4	Papilla, crypt, fissure	0	3	0	0	29	7/14/47	7	
7201	Prolapse, bleeding	4	0	0	3	0	0	21	12/19/47	6	Abscess in 10 days
7281	Pain	4	Thrombosed	0	0	2	1	9	1/8/47	5½	
7289	Bleeding	4	0	0	0	4	1	9	9/5/47	6	
7301	Bleeding	3	0	0	0	3	1	3	12/20/47	6	
7324A	Prolapse	4	0	0	4	0	0	12	10/2/47	6	
7324B	Pain	4	Fissure	0	4	0	0	30	1/21/46	5½	Recurrence
7435	Bleeding	4	Papilla	0	0	3	1	4	9/12/47	5	

cylindrical instrument without a bevelled edge and, therefore, does not distort the existing condition. It has a distal light and so does not

cent solution of phenol in almond oil. The injection is given at the cephalad point of origin of the hemorrhoid and into the sub-

mucosal layer. One can determine that the needle is in the proper layer by observing the free motility of its point. Any fibrosis limiting this motility or impeding the injection is a contraindication to this form of therapy because of the danger of pressure necrosis and the possibility that hemorrhage may result. Should a hemorrhage occur, surgical intervention is contraindicated since the extreme friability of the tissues makes its success unlikely. Hemostasis should be obtained by pressure after which a hot enema (110°F.) should be administered. The injection should be given very slowly and continued until striae are visible on the surface of the mucosa but stopped before blanching occurs. Rarely, and as a palliative measure, 15 per cent phenol in almond oil may be injected into the stalk of a polypoid hemorrhoid. We prefer to inject one hemorrhoid at a time at weekly intervals. Frequently one hemorrhoid may require two or even three injections. No hemorrhages, sloughs or abscesses occurred in our patients who received the injection treatment.

#### EVALUATION OF METHODS

The efficacy of a procedure can be determined only by following a large series of cases over a long period of years. This we have found most difficult to do. In less than one year 207 cases disappeared from our ken and of the entire series of 278 patients it was possible to follow only thirty-three for more than five years. However, most of these continue to come in for their semi-annual check-up and have been studied for eight to ten years. Of this group nineteen submitted to surgery and fourteen were treated by injection. In the surgical group sixty-five hemorrhoids were observed and fifty-two were excised. Of the remaining thirteen none have needed surgical excision and only one has had to be reinjected. In the fourteen patients treated by sclerosis forty-seven hemorrhoids were observed and thirty-one injected. Of the remaining sixteen one was injected later. In other words this small group of thirty-three cases (Table 1) presented 112 hemorrhoids of which twenty-nine were treated palliatively and there were only two failures. Expressed in another manner 25 per cent of the damaged veins were not removed and have remained asymptomatic for more than five years.

*December, 1948*

#### CONCLUSIONS

It is worth while to judge each individual hemorrhoid on its own merits. Surgery, injections and palliation all have their respective places in the armamentarium of a proctologist.

#### DISCUSSION

JOHN CHELEDEN (Philadelphia, Pa.): Dr. Hamilton has presented us with a thought-provoking topic with many points for discussion. Within the limited time available only one or two items can be stressed.

After receiving and studying Dr. Hamilton's report, I conferred with several of my colleagues at Jefferson Hospital. Two of the men are now completing a ten-year survey comprising 1,000 individuals with a follow-up of over 50 per cent of the patients. I have their permission to use some of the figures in a report as yet unpublished.

The following is a pooled summary of the opinion of the members of our department regarding this point: Whereas ten years ago we were injecting hemorrhoids in over 50 per cent of all individuals with symptoms, that figure has decreased gradually so that in the past year 25 per cent or less of all hemorrhoids receive the injection form of therapy. We arrived at our conclusion only after study of a large group of patients carefully watched over a long period of time.

We believe, just as Dr. Hamilton does, that it is worth while to judge each individual hemorrhoid on its own merits. We admit that at times we have been surprised at the results obtained with injection of some hemorrhoids that were designated as requiring surgery at the time of initial examination, but the patients refused surgery. Careful follow-up of this group, however, revealed that the recurrence rate was too high and that subsequent injection or surgery was eventually carried out.

We cannot agree with the premise that many hemorrhoids are better treated by sclerosis or palliative injections. In a few instances, injections may give as good a result but never a better one than careful excision. In too many instances following injection, we never feel as secure as we would following excision.

KENNETH E. SMILEY (Los Angeles, Calif.): I want to compliment Dr. Hamilton on the completeness of this detailed statistical report. It is a difficult and tedious task to review a large series of cases and to evaluate the results, and it is difficult to follow any large series for five years or more as indicated by his charts. I am sure that it would benefit all of us if we could follow a fairly adequate number of cases for several years, but I am inclined to believe that we should be able to make an unbiased evaluation of our work as we go along

and that we should reach conclusions that are accurate. My own opinions are based on such observations but I am not able to produce statistical data to substantiate these opinions.

To me visualization of hemorrhoids is a much more accurate method of determining their characteristics than their palpability or non-palpability. The vessels are so easily compressed by the palpating finger that little information is gained, and I would not care to rely on that to determine the type of treatment necessary. In fact, there are many other factors that should be considered, such as age, general health, occupation and bowel habits, but I realize that it would be difficult to evaluate them in a statistical study.

Long ago I decided that the exact method of removal of hemorrhoids is not of great importance. Dr. Hamilton has described an adequate, simple method which gives excellent results with a minimum of complications. The use or non-use of anesthetic agents in oil for subcutaneous injections will probably remain a controversial subject for some time. It seems to me that the abscesses are of frequent enough occurrence, and the trophic disturbances with resulting delay in healing of enough consequence to contraindicate the use of such anesthetic agents and to rely on other means to control postoperative pain.

It is my opinion that the treatment of hemorrhoids by the injection of sclerosing solution has perhaps fallen too far into disrepute, and I am glad that Dr. Hamilton has again brought the method to our attention. My own opinion in the matter is that few if any hemorrhoids are cured by injections but that in properly selected cases the symptoms can be controlled for varying periods. I can see no objection to such treatment if the operator fully understands the shortcomings of the method and if the patient is frankly advised as to the results he may expect.

It is certainly true, and well borne out by Dr. Hamilton's paper, that small, bleeding, uncomplicated, internal hemorrhoids can usually be controlled for a considerable length of time by the injection of sclerosing solution. On the other hand, the injection treatment of large hemorrhoids, or those complicated by other conditions should not be attempted under ordinary circumstances for the results are poor and the inevitable surgical treatment is made more difficult for both the patient and the surgeon.

ROBERT V. TERRELL (Richmond, Va.): The subject of hemorrhoids is one that I cannot let pass without saying a word. Things have been said here this morning about the injection treatment which I believe I must defend. I enjoyed the paper very much and agree with Dr. Hamilton's remark that the treatment must be tailored in each case to suit the pathologic condition and there is no one

treatment that can be expected to cure all types of hemorrhoids.

The statement has been made by the discussers, however, that the injection treatment does not cure permanently, and with this I wish to take exception. Approximately 75 per cent or more of the hemorrhoids that I am now seeing are being treated by the injection of quinine urea HCl exclusively. As many of you know, we have been doing this in Richmond for a long time and see very few recurrences.

In properly selected cases the only reason that hemorrhoids should recur after treatment is that the treatment was not continued long enough. In other words, treatment must not be discontinued just as soon as the symptoms disappear, but must be continued until the internal hemorrhoids are actually observed to disappear completely. The patient who has internal hemorrhoids and no other anorectal disorder is advised that he may expect a cure by the injection method fully as complete as if the hemorrhoids had been surgically removed.

Treatments are given at intervals of one to two weeks and each internal hemorrhoid is injected at each visit. The hemorrhoidal mass will be seen to grow smaller with each injection until eventually it will disappear altogether although bleeding and protrusion usually cease after the first injection. Occasionally a patient will conclude that he is cured and discontinue treatment as soon as freed of symptoms; in such cases recurrence is to be expected.

A hemorrhoidectomy is, of course, indicated when both internal and external hemorrhoids are present, but when internal hemorrhoids only are present surgery is unnecessary. Surgery means loss of time from work as well as greater expense and discomfort to the patient and there are sometimes undesirable sequelae such as skin tags and abscesses. Dr. Hamilton records an incidence of postoperative abscesses of nearly 3 per cent which is, of course, unusually high. Neither of these complications are seen following the injection method, nor do we see sloughs, infections or hemorrhages when the proper technic is used.

Finding hospital beds is currently so difficult that we are forced to treat many patients by injections who have clear indications for surgery; such patients are grateful for the temporary relief obtained and are advised to have surgery later on when a hospital bed can be found. In summary, I would like to say that we believe that failure to obtain a lasting cure by the injection method in suitable cases of uncomplicated internal hemorrhoids is due to inadequate treatment and that complications are due to errors of judgment in selection of cases or to poor technic.

CLAUDE C. TUCKER (Wichita, Kan.): In the majority of our cases we remove all of the diseased

tissue, including the external as well as internal hemorrhoids. By microscopic examination of the tissue we have found that 98 per cent of our cases have external as well as internal hemorrhoids. Ninety-eight per cent of our cases show infected anal ducts either acute or chronic which is the primary cause of the hemorrhoids. About 60 per cent of these cases show thrombi which are localized or extend around the anal margin. These thrombi are also caused by infection in the anal ducts.

Therefore, if you inject a sclerosing solution into internal hemorrhoids which have to swell before shrinking, you are blocking drainage from the ducts. Thus, you are holding the injection. Furthermore, when there are external hemorrhoids and thrombi, injections are contraindicated.

Louis E. Moon (Omaha, Neb.): I wish to take issue with some of those who have discussed Dr. Hamilton's paper.

I think that as far as the treatment of hemorrhoids is concerned, the removal of them is the proper treatment. It cannot and should not be done on every individual. We do occasionally see invalids and old people whom we have to treat by the injection method, but as a working rule, I think

we, as representatives of the American Proctologic Society, should recommend the removal of hemorrhoids rather than the injection of them.

The injection treatment does not cure hemorrhoids, regardless of what anyone says. It does sclerose the vessels and it shrinks the redundant tissue for the time being and it allays bleeding, but in a year or two, or later, the circulation in the hemorrhoid is re-established and your redundant tissue is again present. This excess of tissue has to be removed before the hemorrhoid is cured. I do not believe that our Society should go on record as having said that the injection treatment of hemorrhoids is preferable to the operative treatment. I believe that all hemorrhoids should be removed; but if we do find a patient who cannot withstand an operative procedure, we can then suggest palliative measures and one of the palliative measures is the injection treatment. If we are to treat our patients properly, we, as proctologists, should not try to see how many hemorrhoids we can inject; but we should see that the treatment is proper for the patient and in most hemorrhoid cases the removal of the hemorrhoid is the proper treatment.



# THE PROBLEM OF FOREIGN BODIES IN THE COLON AND RECTUM

F. GEORGE REBELL, M.D.  
*Los Angeles, California*

RELATIVELY little can be found in the literature regarding the subject of foreign bodies in the terminal portion of the bowel. Infrequently a case is published but the attention it attracts is largely due to its bizarre nature and to the extraordinary circumstances associated with the introduction of the foreign body. The attempt has therefore been made to analyze the sites at which foreign bodies were lodged in a series of patients, types of objects encountered, resultant injuries with their possible complications and the methods employed for treatment and extraction.

Sometimes cases occur which present puzzling diagnostic problems, associated with a background of persistent anorectal or colonic symptoms. When carefully examined, it will be found that a foreign body is the cause of such a protracted morbid condition. Several instances of diagnostic difficulties of this kind will be presented. Twenty-four cases will be described involving different types of foreign bodies which lead to varying degrees of anorectal and colonic injuries. The majority of these cases were observed over a ten-year period on the proctologic service at the Los Angeles County General Hospital. The foreign bodies ranged from vegetables to oil cans and were introduced both intentionally and otherwise.

It is not unusual to discover portions of toothpicks embedded in an anal crypt, a condition which may lead to the formation of a fistula. Similarly, pieces of fish and fowl bones, small berry seeds, dental fillings and the like are also found. In many cases a foreign body in the distal portion of the colon is passed spontaneously and, therefore, never comes to the attention of the proctologist. Furthermore, the majority of persons are extremely hesitant about calling for assistance when complications arise after a foreign body has been voluntarily introduced into the rectum. Others may be unaware that the cause of their rectal complaint is due to a foreign body which accidentally entered the terminal portion of the

colon either by way of the abdominal cavity, the rectum or orally through the gastrointestinal tract.

In the perianal region any external fistulous opening of doubtful origin should arouse suspicion of the possible presence of a foreign body in the rectal ampulla. Moreover, any foreign body entering the abdominal cavity by way of the rectum constitutes a decided danger requiring immediate surgical intervention. When surgical treatment is delayed for more than six hours, the risk is greatly increased. If, on the other hand, an early diagnosis is made and the patient is fortified with modern chemotherapy and especially with antibiotic therapy, the danger can be materially lessened.

The majority of self-introduced foreign bodies can usually be detected by digital palpation of the rectum. Such foreign bodies frequently lodge in the rectal ampulla which is the most spacious segment of the terminal portion of the bowel. It is only by actual force that most objects will pass through the rectosigmoid junction which fortunately acts as a valvelike barrier. However, any sudden act of abdominal straining such as coughing or sneezing will result in an increase of intra-abdominal pressure and may cause perforation. Sigmoidoscopic as well as x-ray examinations are invaluable aids in determining the location, size and character of the foreign body. The sigmoidoscope, however, should be introduced with extreme caution in order to avoid forcing the foreign body beyond reach or through the bowel wall.

One finding which was encountered several times in the present series should be taken as a warning, namely, that far too frequently trauma is produced through insertion of a thermometer or a rectal irrigation tip. Often the anterior quadrant of the rectal ampulla is lacerated by a rectal dilator causing profuse bleeding which assumes alarming proportions in many instances. Damage of various degrees was noted on several occasions, involving the prostrate gland and urethra in the male and

the rectovaginal septum in the female. Forceful insertion of any dilator, enema tip, thermometer or similar appliance into the rectum via the anal canal without adequate precaution invites trouble and possible fatal complications. For this reason nurses, orderlies and assistants in physiotherapy should be adequately instructed as to the relationship of the anal canal to the rectum. A good rule to follow is to insert the appliance always in the direction toward the umbilicus for the first 3.8 cm. and then to follow cautiously the curvature of the coccyx and sacrum which is practically at right angles to the direction of the first insertion.

The following outline the twenty-four cases of the present series:

#### CASE REPORTS

**CASE I.** Upon pelvic examination a white female, fifty-three years of age, revealed a firm, indurated mass in the cul-de-sac attached anteriorly to the uterus and posteriorly to the rectum. The mass gave the impression of widespread, diffuse cellulitis infiltrating all adjacent structures. The possible presence of carcinoma of the broad ligament or of the rectum was at first taken into consideration. A barium enema, however, disclosed an indefinite, filling defect of the upper rectum which was thought to be of neoplastic origin.

Two years prior to this examination the patient had submitted to a pelvic operation after which she was told by her physician that due to her critical condition the operation had been interrupted in order to avoid sacrificing her life. Several months later the patient began to complain of bearing-down sensations in the rectum which gradually became worse. A progressive type of constipation including occasional obstipation added to her discomfort.

Sigmoidoscopic examination revealed a strictured area at the 11.5 cm. level. A marked degree of hyperemia and edema of the mucous membrane was also encountered. This condition was caused by two 4-inch gauze packs extending through a pelvic fistula into the rectum. Unquestionably these had eroded through the cul-de-sac following the operation two years previously. The packs were removed by long bronchoscopic forceps and only a moderate degree of bleeding ensued. Two small areas of tissue were removed for biopsy which were reported to be pyogenic granuloma of the rectum. Three months later the pelvic fistula was seen to be closing spontaneously and edema as well as inflammation had subsided. Constipation was corrected subsequently. This case proves that the cause of an obscure pelvic disturbance may be detected by proctoscopic examination.

**CASE II.** A young adult male self-introduced a small vaseline jar with its cover into his rectum two days before entering the hospital. Manual removal was attempted without success. Under spinal anesthesia the sphincter ani muscle was divulsed manually while pressure was applied above the symphysis pubis and the jar in the rectal ampulla was grasped and delivered with obstetrical forceps.

**CASE III.** A male, fifty-nine years of age, self-introduced a carrot into the rectum two hours before being seen at the hospital. Palpation disclosed a firm mass at the tip of the examining finger. Under pentothal anesthesia sigmoidoscopic examination was performed and the carrot was discovered in the rectal ampulla. The blunt end presented itself distally and was about 2 cm. in diameter. All attempts to deliver the object failed. The patient was finally returned to the ward because of his marked apprehension. However, several hours later he manifested severe abdominal symptoms and was rushed to the operating room. The carrot was found inside the abdomen lying above and parallel to the aorta. A transverse tear in the region of the rectosigmoid junction was noted through which the terminal 3 cm. of the carrot could be seen extending into the lumen of the bowel. Upon removal the carrot measured 26.5 cm. in length and 3.8 cm. in diameter. The large bowel was exteriorized through the lower end of the rectus incision and subsequently closed. The patient recovered after a stormy convalescence.

**CASE IV.** A male, thirty-eight years of age, was admitted with complaints of insomnia, dizziness, restlessness and abdominal cramps which he attributed to liver pills. Upon rectal palpation a large, firm, immovable mass was located well above the sphincter ani muscle. Upon further questioning the patient admitted not having had a bowel movement for four days. X-ray revealed the open end of a tumbler facing downward with its base tilted slightly to the right. The tumbler was delivered with forceps which were applied cautiously while the patient was under spinal anesthesia. Moderate bleeding of the mucous membrane ensued. After extracting the object from the rectal ampulla an oil retention enema was administered to allay mucosal irritation. Any attempt to extract this glass object without proper anesthesia or as an office procedure undoubtedly would have resulted in breaking the tumbler, with resulting massive hemorrhage and possible perforation.

**CASE V.** A male, forty-one years of age, on two previous occasions had self-introduced objects into his rectum. This time the patient had used an oil can with a potato stopper which he admitted had produced considerable bleeding at the time of insertion. The nature of the object was determined by careful digital examination of the rectum. The

TABLE I

Type of Object	Manner of Introduction	Site of Lodgment	Resultant Injury	Method of Extraction
Case I Two 4-inch gauze packs	Left at operation two years previously	Cul-de-sac attached to the uterus and the rectum	Strictured area, edema and hyperemia; erosion through cul-de-sac and into rectum through a pelvirectal fistula	Bronchoscopic forceps
Case II Small vaseline jar	Self-introduced	Rectal ampulla	Denuding of the mucous membrane with subsequent bleeding	Spinal anesthesia; pressure above symphysis; obstetrical forceps
Case III Carrot	Self-introduced	Abdomen	Transverse tear in the rectosigmoid junction	Surgically removed and tear repaired
Case IV Tumbler	Self-introduced	Rectal ampulla	Insomnia, dizziness, abdominal cramps, no bowel movement for four days	Spinal anesthesia; removed with forceps
Case V Oil can	Self-introduced	Rectal ampulla	Massive hemorrhage	Pressure on the symphysis pubis
Case VI Teacup	Self-introduced	Rectal ampulla	Mucosal laceration	Removed in fragments with specula and sponge forceps
Case VII Chili bottle	Self-introduced	Rectal ampulla	No bowel movements for three days	Spinal anesthesia; deep pressure at the symphysis, finger manipulation
Case VIII Thermometer	Taking temperature of a child	Rectal ampulla	Moderate rectal bleeding	Passed spontaneously on bowel movement
Case IX Thermometer	Taking temperature of child	Rectal ampulla	Moderate rectal bleeding	Passed spontaneously on bowel movement
Case X Thermometer	Taking temperature of infant	Rectal ampulla	Not mentioned	Extraction with Allis forceps and index finger for guide
Case XI Toothpick	Swallowed	Cecum	Perforation and death	Discovered at postmortem
Case XII Large bottle	Self-introduced	Both ischiorectal fossae	Obstipation	After fragmentation the bottle was extracted
Case XIII Beer bottle	Self-introduced	At the level of the middle Houston valve	Generalized peritonitis	Incision in the rectosigmoid colon; proximal loop colostomy
Case XIV Coca-Cola bottle	Self-introduced	Rectosigmoid colon	Rectal hemorrhage with some clots	Laparotomy
Case XV Whiskey glass	Self-introduced	Rectal ampulla	Obstipation and partial obstruction	Manipulation and pressure above the symphysis pubis
Case XVI Wooden rectal dilator	Self-introduced	Rectal ampulla	Obstipation and partial obstruction	Manipulation and pressure above the symphysis pubis

TABLE I (Continued)

Type of Object	Manner of Introduction	Site of Lodgment	Resultant Injury	Method of Extraction
Case xvii Carrot	Self-introduced	Through the rectal ampulla into the sigmoid colon	Partial obstruction	Spinal anesthesia; grasped with uterine curet and uterine forceps
Case xviii Test tube	Self-introduced	Rectal ampulla	Partial obstruction	Pressure above the symphysis pubis, two fingers in the rectum
Case xix Vaseline jar	Self-introduced	Rectal ampulla	Complete obstruction	Spinal anesthesia; Kielland forceps to the anal margin, then large bone forceps
Case xx Whiskey bottle	Maliciously introduced	Rectal ampulla	Complete obstruction	With Rocker forceps and by manipulation and pressure above the symphysis pubis
Case xxi Glass tube	Not mentioned	Rectal ampulla	Partial obstruction	Spontaneously passed
Case xxii Rectal tube	Self-introduced	Transverse colon, after enema of proximal sigmoid loop	Death	Sigmoid colon opened and tube delivered; left sigmoidostomy; cause of death peritonitis and shock
Case xxiii Irrigation tube	Self-introduced	Sigmoid colon	Hyperemia; enlargement of the glands in the mesocolon	Surgery for exploration; the tube was milked down and grasped by forceps
Case xxiv Piece of bone	Swallowed	Left ischiorectal fossa	Pain, discharge, bleeding; abscess in the left ischiorectal fossa	Through an anoscope removed with Allis forceps

foreign body was delivered without anesthesia by pressure above the symphysis pubis. The oil can measured 7.6 by 7.6 by 6.3 cm.

CASE VI. On one of the previous occasions a large teacup, its edges broken and ragged, presented itself in an inverted position in the rectal ampulla. It was found to be impinged anteriorly near the pubic bone, posteriorly in the region of the coccyx and laterally to the ischial tuberosities. The cup was removed in fragments by employing two Sims' specula and sponge forceps. A small degree of mucosal laceration resulted from the extraction. Treatment consisted of instillation of half strength witch hazel three times daily. The object could be removed without anesthesia due to the patulous, relaxed and dilated condition of the anal outlet.

CASE VII. A male, fifty-six years of age, was admitted for proctologic attention after failing to

have a bowel movement for three days. The patient stated that in order to initiate defecation he was accustomed to dilating the anal orifice with various objects which at this time had happened to be a chili bottle. Without anesthesia the bottle could only be brought down to within 2 inches of the anal outlet. Under spinal anesthesia deep pressure was applied at the level of the symphysis pubic while finger manipulation of the bottle was accomplished from below through a patulous anal outlet. The bottle measured approximately 2.5 by 15 cm.

CASES VIII and IX. In two cases thermometers were broken in the rectum while attempting to take routine temperatures of children, one four and the other seven years old. The thermometers were passed spontaneously upon bowel action followed by a moderate amount of rectal bleeding.

CASE X. Upon taking the rectal temperature of a six months old infant, a nurse broke the ther-



nometer in the rectum. It was extracted with Allis forceps using the index finger of the left hand as a guide.

CASE XI. A male patient was admitted in shock, with a vague history obtained from relatives suggestive of symptoms similar to obstruction. The patient subsequently died. Postmortem examination revealed a perforated cecum caused by a toothpick.

CASE XII. A male, fifty-four years of age manifesting symptoms of rectal disorder, was referred to the proctologic service. Digital examination revealed a jagged, irregular piece of glass which had burrowed itself into both ischiorectal fossae. This proved to be a large bottle measuring about 7.5 by 7.5 cm. and lying approximately opposite the sacral prominence. Exposure was accomplished by the use of two medium width Sims vaginal specula. After fragmentation by means of a large bone rongeur the rim of the bottle was grasped and very cautiously extracted. No intraperitoneal perforation of the rectum occurred.

CASE XIII. Five years later this patient returned to the hospital. Upon this occasion he stated that he had inadvertently passed a standard 11 ounce beer bottle into his rectum while in the bathtub. He suffered considerable pain and complained of much abdominal tenderness. Palpation located the base of the bottle at the level of the middle Houston valve. Recovery of the bottle was attempted by way of the anal orifice using Kielland's forceps. Many other types of retractors were unsuccessfully tried even after the tip of the coccyx had been resected and the rectum split posteriorly in the anocecocygeal line. Moreover, after a left rectus incision it proved impossible to force the bottle out of the rectum by intra-abdominal pressure alone. Finally the bottle was extracted and delivered through an incision into the rectosigmoid colon. Colostomy of the proximal loop was performed but failed to prevent generalized peritonitis. The patient recovered after a stormy convalescence.

CASE XIV. A male, forty-three years of age who had been intoxicated for four days, developed a rectal hemorrhage of bright red blood with some clots. Diagnosis of a foreign body was made on palpation of the abdomen. A hard, movable mass in the form of a bottle could be outlined. Exploratory laparotomy disclosed no rents or tears in the sigmoid or descending colon. However, the contour of a bottle was plainly visible in the rectosigmoid colon, the base approximately 12.5 cm. above the anal outlet and the neck extending into the sigmoid. A small ecchymotic area was observed on the anterior wall of the sigmoid but no evidence of necrosis or perforation was encountered. The bottle was eased through the pelvis by compression of the sigmoid and gradually delivered through the rectum by gentle traction from below. The foreign

body proved to be a Coca-Cola bottle. Early surgical intervention in this case was undoubtedly the cause of recovery.

CASE XV. A male patient, forty years of age, lost a whiskey glass during one of his relaxed drinking moments. It was later found in his rectum and recovered without fragmentation of the glass by finger manipulation while pressure was simultaneously applied above the symphysis pubis.

CASE XVI. A male, sixty-nine years of age, had yielded to the advertisements describing the benefits derived from the home use of a wooden rectal dilator. A short time later the dilator was recovered from the rectum by manual manipulation with simultaneous pressure over the symphysis pubis.

CASE XVII. A male, forty-seven years of age, applied vaseline to a carrot and inserted it into his rectum for relief of itching piles. Thereupon he slipped accidentally and fell on his buttocks which caused the carrot to be pushed upward in the rectum out of reach. Under spinal anesthesia the carrot could be palpated with the tip of the index finger and the presenting end visualized by the use of Pennington's proctoscope. Various hemostats and other instruments failed to secure a firm grasp on the vegetable. Finally a sharp uterine curet was applied to the bulky stalk which facilitated grasping the lower portion with uterine forceps. The carrot was then cautiously extracted.

CASE XVIII. A male, fifty years of age, who had been suffering from constipation for several days attempted to relieve himself by inserting a test tube into his rectum which he was unable to recover later. By suprapubic pressure on the abdomen with two fingers inserted in the rectum the test tube was delivered without breaking. It measured 15.2 by 3.2 cm. and a cork stopper was found in its hollow end.

CASE XIX. A forty-six year old male with complaints of protruding hemorrhoids associated with intense itching tried to reduce them manually but failed. He next resorted to a vaseline jar with its cap (the cap end inserted first) to push the hemorrhoids back into the rectum. The jar became lodged in the rectum and all efforts of the patient to recover it were unsuccessful. A proctologic examination revealed that the jar was wedged transversely across the rectal ampulla at the level of the middle Houston valve. Under spinal anesthesia Kielland's forceps were used to retract the jar to the anal margin; then it was grasped with large, coarse-toothed bone forceps. No gross tears were made in the rectal mucosa and neither packing nor suturing was necessary. The jar measured about 6.3 cm. in diameter.

CASE XX. A male, fifty-nine years of age, gave two hitch-hikers a lift in his car; and when he refused a social drink, they became angry and forcefully inserted a whiskey bottle into his rectum.

Upon careful proctologic examination a firm, solid object which felt like the bottom of a bottle could be palpated 10 cm. distal to the anus. No bleeding or abdominal symptoms were observed. The bottle was carefully extracted by means of Rocker forceps combined with manual manipulation as well as suprapubic pressure. When recovered, the bottle, 5 by 3.6 cm., was broken in two pieces.

CASE XXI. A male, thirty-seven years of age, was unable to recover a glass tube which he had inserted into his rectum. Various attempts to extract the tube manually failed but a short time later it was passed spontaneously.

CASE XXII. A female, sixteen years of age, stated that as long as she could remember she had been troubled with constipation and particularly with excessive flatulence. Relief could be obtained only by inserting a soft rubber rectal tube. About a month prior to admission the rectal tube got out of hand during insertion into the rectum and consequently remained in the colon. Since then she experienced difficulty at defecation and the abdomen became progressively more distended. Upon palpation of the abdomen a moveable, soft mass could be detected just above the level of the umbilicus. Before x-rays were made a tentative diagnosis of Hirschsprung's disease or megacolon was made. A flat plate of the abdomen, however, revealed a portion of the tube to be coiled in the transverse colon. Abdominal distention became rapidly more acute. A proctologic consultation was requested and it was found that a fecal mass was filling the entire rectal ampulla. Repeated retention enemas of warm oil were recommended; treatment, however, proved unsuccessful and only aggravated the situation. Upon operation an enormously distended transverse colon was encountered with fecal matter impacted around the coiled colon tube; this had migrated to the proximal segment of the sigmoid loop following administration of the oil enemas. The sigmoid portion of the colon was incised and the tube delivered. A left sigmoidostomy was performed proximal to the opening previously made and attached to the incisional wound below the umbilicus. The patient lived only a few hours and the cause of death was recorded as postoperative peritonitis and shock.

CASE XXIII. A female, forty years of age, after unsuccessfully attempting a colon irrigation lost the tube in her rectum. A flat plate x-ray of the abdomen showed the tube to be lodged in the sigmoid colon just below the promontory of the sacrum with the upper end directed toward the cecum. Exploratory laparotomy using a left paramedian incision was performed. The sigmoid colon around the distal end of the colon tube revealed marked hyperemia and enlargement of the adjacent glands in the mesocolon. No evidence of erosion or ulceration through the bowel muscula-

ture was encountered. The tube was gradually and cautiously milked down into the rectum. When the tip entered the rectum, it was grasped with forceps guided by digital palpation and was successfully removed.

CASE XXIV. A male, seventy-eight years of age, one year prior to hospitalization consulted his family physician for piles which were accompanied by haemorrhage. A few months later throbbing, persistent pain developed near the rectal outlet associated with a discharge from the rectum. The patient stated that during the past month he had been aware of an occasional loss of bright red blood from the rectum. Bowel movements were regular without the use of cathartics. Proctologic examination gave evidence of a recently formed abscess in the left ischio-rectal fossa. Two discharging sinuses separated from each other by a distance of about 3 cm. were seen approximately 3.5 cm. from the anocutaneous line. Upon digital examination a sharp foreign body was felt extruding from the opening of the primary fistula at the level of the crypt line in the left lateral quadrant. The foreign body was removed with Allis forceps through an anoscope and proved to be a piece of bone about 5 cm. long, 1.5 cm. wide and 5 mm. thick. The extruding portion of this bone was tapered to a fine point while the blunt end had been lying in the fistulous tract within the rectum. The abscessed crater was uncapped and the opening of the primary fistula excised. The canalized process of the tract was thoroughly cauterized.

#### SUMMARY

1. Foreign bodies which erode or rupture into the abdominal cavity require surgical intervention within six hours after manifestation of symptoms.
2. Self-introduced foreign bodies can usually be diagnosed by digital palpation and proctoscopic examination; roentgen study of the condition is a valuable adjunct.
3. Greater caution should be exercised when introducing thermometers, enema tips and other appliances into the rectum. Nurses, orderlies and assistants in physiotherapy should have precise knowledge of the anatomy of the rectal ampulla and of the anal canal in order to preclude accidents.
4. The indiscriminate use of rectal dilators and the wholesale practice of colonic irrigations by the general public are dangerous practices.
5. Perianal discharges of unexplained origin, sudden changes in bowel habits as well as acute abdominal symptoms call for thorough proctologic examination on the basis of a carefully collected history.

## DISCUSSION

GASPAR ANGELO (Cambridge, Mass.): Dr. ReBell's paper has added a great deal to the medical literature on this subject. As Dr. ReBell stated the literature is abundant with case reports of foreign bodies in the rectum and colon and, as his series of cases reveals, there is almost no limitation to the type of foreign objects that could be encountered.

I am in total agreement with him when he states that most of these case reports merely indicate the presence of such an object and do not emphasize the fact that these foreign bodies by their mere existence are responsible for a large variety of serious complications or, what is even more likely, dangerous problems arising from their removal.

In regard to anorectal fistulas caused by foreign bodies I have found that in my last series of 150 cases of fistulas-in-ano two (1.3 per cent) were definitely associated with this condition. Inasmuch as this is not often noted in the literature, I would be interested to learn the experience of others.

The majority of foreign bodies are swallowed accidentally or intentionally. If a swallowed object passes the esophagus, pylorus and ileocecal valve, its most common point of arrest or blockage is the lower inch of the rectum or anus. Thus, a digital examination will usually make the diagnosis. However, proctosigmoidoscopic examination or x-ray may be necessary to locate objects higher up. Foreign bodies in the rectum or sigmoid should be removed at the earliest possible moment. Purgatives are, as a rule, banned. The exaggerated peristalsis they excite may force a sharp, pointed object into the tissue and invite trauma, laceration, and perforation.

At the proctologic clinics of the New England Medical Center and the Mount Auburn Hospital we have had a few similar experiences in regard to use of rectal thermometers. The entire personnel has been instructed in the cautious use of the thermometer.

Dr. ReBell's comment about the presence of peritonitis in conjunction with foreign bodies is most interesting to me inasmuch as in my proctologic practice I have not encountered similar cases. His experience teaches us that we must bear in mind the possibility of trauma in cases of peritonitis even when there may be no external evidence of such. Routinely, all patients that have had foreign bodies in the rectum or colon are placed on sulfathaladine therapy.

Although we frequently encounter sexual perversion in this type of case, Rosser in 1930 called attention to the fact that foreign objects are often employed by the patient to alleviate pre-existing pathologic conditions. Hence, we cannot be con-

tent with the removal of the object without correcting the associated pathologic condition. In 1944 Macht sited a long list of an unusual variety of foreign bodies gathered in his review of the literature as did Vaughn and Martin in 1946.

I would like to summarize three interesting cases of my series:

CASE I. Mr. J. C., a fifty year old Italian laborer, was seen as an acute, urgent problem because of sharp, agonizing pain in his rectum. During the previous evening he had ingested a meal consisting of large, flat macaroni. Digital examination revealed the presence of a flat piece of wood 10 by 1.2 cm., pointed at both ends, lying diagonally in the anus and rectum. Removal was easily accomplished with only slight hemorrhage. (Because the patient was placed on a liquid diet, his wife was about to serve him a very fine spaghetti in broth and in preparation noted the presence of a fine splinter of wood which was similar to that removed on the same day, thus saving the patient a possible second foreign body.)

CASE II. Mr. M. K., a twenty-six year old naval veteran, presented himself with constant tenesmus of five months' duration. Because of a combat neurosis, he was subjected to numerous studies among which a barium enema and a gastrointestinal series were included. Digital examination revealed the presence of a hard, ball-shaped, smooth mass, 7.5 cm. in diameter lying in the ampulla. He refused hospitalization and the mass was repeatedly chipped with a Kelly snap until it could be easily removed. Subsequent study revealed that the mass was composed of solid, inspissated barium. The resultant proctitis as well as the neurosis quickly subsided.

CASE III. Miss M. D., age thirty-five, came to the office complaining of sharp pain in the anal area of four days' duration; the pain was aggravated with bowel movements. Investigation revealed a pointed object protruding through the skin in the posterior commissure. This was removed with ease and a whole, blue toothpick was extracted. Upon questioning the only contact she had with a blue toothpick was at a formal tea that she attended two weeks before at which sandwiches were served, held together with red, white and blue toothpicks. Complications of a perianal abscess and a fistula-in-ano required surgery.

ALVIN BALDWIN (Dallas, Texas): Dr. ReBell has brought to our attention an interesting and informative subject that is seldom encountered in the literature, chiefly because the presence of a foreign body in the rectum or an injury therefrom is relatively uncommon. But when it does occur, this is a condition that demands immediate and definitive treatment.

The approach to any patient with a foreign body in the rectum should be to determine the location

of the foreign body and the possible route it may have traversed. Objective signs should be observed, such as presence of shock, abdominal tenderness, rigidity and perianal trauma, keeping in mind that the size of or the absence of a perianal wound has no bearing on the severity of the injury.

Any elevation of temperature or white blood count should be noted, these, however, to be used only as an aid in arriving at a decision as to how a case can be best managed.

Spinal anesthesia for relaxation of the sphincter muscles, with the aid of a variety of mechanical contrivances, permits in most instances recovery of the foreign body in a reasonable length of time.

The lithotomy or Sims position is no doubt preferable, due to the likelihood of losing the object in the sigmoid colon when the patient is placed in the jack-knife position. Careful sigmoidoscopy should follow the extraction of any foreign body to determine the presence of a possible injury to the wall of the bowel.

There are three susceptible anatomic areas which are particularly important when injuries occur as a result of foreign bodies in the rectum: first, the abdominal viscera following the usual pattern of a ruptured viscus; second, the postrectal and pararectal spaces which may be subjected to a violent anaerobic infection when contaminated by a wound through the rectum and third, the posterior extraperitoneal space of the abdomen, through which a foreign body may pass into the postdiaphragmatic region and on into the chest. Injury to any one of these areas requires immediate surgery.

The method of management proved to be most satisfactory in the presence of an abdominal injury is to explore the abdominal region immediately, find any perforated viscus, repair it and do the preferred type of colostomy proximal to the perforation provided the injury is to the colon; or, if a perforation cannot be demonstrated, the presence of small particles of feces in the abdomen constitutes a justifiable reason for a colostomy in the upper sigmoid. The abdomen is then closed. The patient is placed in any suitable position to enter the postrectal space where drains are placed through which the space may be irrigated with antibiotics or oxidizing agents.

Parenteral medication consists of streptomycin, 5 Gm., every four hours intramuscularly for forty-eight hours, and large doses of penicillin for several days as well as other supportive therapy.

An important complication often associated with this type of injury is a psoas abscess, not uncommon when these injuries occur. It should be kept in mind when there is severe pain on extensive flexion, internal or external rotation of the thigh.

In caring for the colostomy the distal segment is not irrigated until about the eighth or tenth day.

Since the bowel is defunctioned, there is no particular hurry to empty its contents. Irrigation of the proximal end may be started on the third or fourth day. The colostomy is then closed in the usual period of time one waits to close any temporary colostomy. This outline of treatment increases the morbidity and veers away from the spectacular, but it is safe.

LOUIS J. HIRSCHMAN (Detroit, Mich.): I should like to speak about some of the things that occur to children and I refer particularly to the crying baby who comes into a pediatrician's office and no cause is found for the child's distress.

So many of these babies, particularly those in the crawling stage, pick up various foreign bodies from the floor and swallow them and the first intimation that the child has done so is crying and discomfort and upon careful examination very often small foreign bodies in the anal canal will be found accountable for the child's discomfort.

I should like to mention some other foreign bodies. Most of the discussers have spoken about careful instructions to the nurses and orderlies in regard to insertion of a thermometer into the rectum. No matter how careful you are if you leave a thermometer for a moment, some patients, and often children, will investigate and with a little pressure the thermometer will disappear. An easy way to prevent this is to wrap an ordinary rubber band around the outer end of the thermometer. If there is a rubber band around the part that protrudes, you do not need to put a thermometer any further in the rectum than you would in the mouth—it cannot go further.

Concerning enema tubes sometimes I think we all should instruct every individual in every hospital where we operate never to use a hard metal, hard rubber or glass tip when giving enemas. Always have an ordinary urinary catheter slipped over the enema tip for all enemas and it will not produce trauma and is not so likely to escape, particularly if it remains attached to the tube and to the enema bag. If a nurse or mother knows a child has been playing with a pin or small object and swallowed it, usually the pediatrician gets a call. A simple, satisfactory way of helping deliver that foreign body not only unscathed but the patient uninjured is to have the patient swallow bits of absorbent cotton flavored with wintergreen, peppermint or the like. The cotton will follow the open safety pin or piece of glass down through the intestinal tract and the foreign body wrapped in cotton usually is evacuated with the stool.

RUDOLPH V. GORSCH (New York, N. Y.): One of the main difficulties in removing foreign bodies is the trauma incident to repeated manipulations with possible perforation of the gut followed by abscess formation and fistulization. The following may be of value in dislodging foreign bodies and avoid-

ing trauma: First, the coagulation current may be useful in shrinking or burning through wooden objects or fish bones lodged transversely in the bowel, second, a wire looped snare may find easy adjustment around hard or metal objects such as a plastic shaving brush or a radiator valve and third, a biopsy scissors that has a toothed ratchet which fixes an object while it cuts may prove useful for foreign bodies impacted low in the rectum.

DR. REBELL (closing): I thank the discussers for their favorable comments and have only this additional note to make regarding thermometers which was mentioned by Dr. Hirschman. He re-

ferred to thermometers which were inserted into the rectum of infants by nurses who temporarily forgot them, only to return later to find that the thermometer had slipped into the rectal ampulla.

The three cases included in my report which were not presented disclosed broken thermometers lodged in the rectum; this was the result of unfamiliar anatomic knowledge of this region, combined with improper and forceful application of the thermometer. Therefore, I wish to re-emphasize the importance of caution whenever tips, thermometers or instruments are inserted into the rectum.



# SACRAL AND PRESACRAL TUMORS

STUART T. ROSS, M.D.  
Hempstead, New York

SACRAL and presacral tumors are not common but are of such importance when present that their diagnosis becomes a Meadowbrook Hospital in 67,769 admissions had two osteogenic sarcomas and two giant cell tumors of the sacrum. These figures repre-

TABLE I

No		Sex		Age	Presacral Mass	Bone Destruction	Remarks
		M	F				
11	Teratoma and teratoids	5	6	All infants except 3	8	1 (malignant)	3 Malignant 1 with bone destruction and irradiation; death from malignancy
18	Chordoma	10	8	M—23-70 Av.—50.4 F—5-65 Av.—45.5	17 Post-sacral mass in one	All except 4	Recurrence in 9 Not noted in 5 None in 4 (3 mo., 1 yr., 5 yr., 9 yr.)
15	Dermoids	0	15	4 mo. to 67 yr. Av.—28.4	In all	None	Pain in 8 Sinus in 4 Partial incontinence 1
1	Appendiceal mass	1	0	4	Yes	No	
6	Ependymal cell gliomas	5	1	32-68 Av.—43.5	In all	In 3	Pain in all Cure in 2 only (3 yr. and 9 yr.)
4	Giant cell	0	4	19-57 Av.—34.7	In all	In all	Pain in all 2 deaths 1—no recurrence—9 mo. 1—no recurrence—10 yr.

matter of primary concern to the proctologist. Since it is doubtful that a single observer ever has the opportunity to see a large number of these rare tumors, their diagnostic characteristics must be discovered by mass study of cases reported by numerous observers. For the same reason each case reported adds to our aggregate knowledge of the subject.

*Incidence and Types.* Whittaker and Pemberton<sup>37</sup> report an incidence of all kinds of presacral tumors of one in 40,000 general hospital admissions. In 440,255 admissions from 1939 to 1946 inclusive Kings County Hospital recorded seven cases of sacral tumors consisting of the following: one hypernephroma (from the left kidney); two osteogenic sarcomas; one endothelial myeloma; one osteoma; one osteochondroma and one chordoma.

sent a combined incidence of one in 46,183 general hospital admissions, which compares closely with the one in 40,000 of Whittaker and Pemberton.

Mabrey in 1935<sup>25</sup> collected from the literature 150 cases of chordoma which he analyzed. In 1944 Faust, Gilmore and Mudgett reported 102 more.<sup>9</sup> I have been able to find in the recent literature eighteen additional cases<sup>2,6,9,10,12,19,25,27,30,37</sup> to which should be added one case reported herein. In addition the literature of the past ten years contains reports of other tumors of the sacrococcygeal region as noted in Table 1. In each of these a presacral mass was present.

*Age and Sex.* Nearly all teratomas are found in infancy and occur in about equal numbers in males and females. Chordomas are

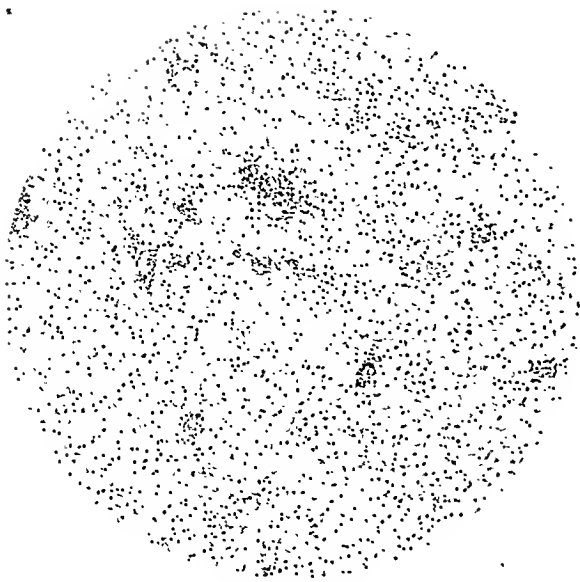


FIG. 1. Photomicrograph, Case 11; chordoma.

found more frequently in males. The average age in this series was 50.4 years in males and 45.5 years in females. Dermoids are discovered most often in young women in their twenties. I have been unable to find a single report of a presacral dermoid in the male. Although a preponderance so overwhelming must have a definite reason, no convincing explanation for the phenomenon is known.

*Etiology.* No attempt will be made here to describe or list all of the many theories of origin of sacral and presacral tumors. Although the subject is controversial, it is generally accepted that chordomas are derived from notochordal remnants and that teratomas in some instances at least may represent parasitic twins. Dermoids are undoubtedly the result of faulty embryonic development although it is impossible to determine with certainty whether or not they are derived from the tissues of the proctodeum as some assert.

*Pathology.* A true dermoid is an encapsulated ectodermal cyst lined with stratified squamous epithelium. Sebaceous glands and hair may or may not be present, but the cyst is usually filled with sebaceous material.

As the name teratoma implies the tissues found in a teratoma are derived from all three germ layers and not from ectoderm alone. When the tissue structures are well organized and actual portions of organs can be identified, these tumors are frequently designated teratoids. Neither dermoids nor teratomas are in-

vasive tumors *per se* but the latter frequently become malignant.

Although a chordoma may be encapsulated when early, it is locally invasive and characteristically invades the sacrum. The tumor is soft and may be sufficiently elastic to simulate

TABLE II  
SACROCCYGEAL CHORDOMAS

		Analysis of 150 Cases Previous to 1935	Analysis of 16 Cases Since 1935	
			No.	Per cent
Average age	Male . . . .	50.3		44.6
	Female . . .	43.2		45.8
Sex	Male . . . .	58	10	
	Female . . .	27	6	
Symptoms				
	Pain . . . . .	37	24.6	
	Pain and tumor . . . . .	22	14.6	14
	Tumor . . . . .	15	10.0	2
	Constipation . . . . .	5	3.3	4
	Pressure . . . . .	4	2.0	2
	Blood . . . . .	2	1.3	
	Urinary disturbance . . . . .	3	2.0	
	Swelling of thigh . . . . .	1	0.6	
	Ulcer . . . . .	1	0.6	
	Numbness . . . . .	..	..	2
	Incontinence . . . . .	..	..	4

a cyst. Upon section it is gray, trabeculated and rather gelatinous. Microscopically the tumor consists of pale cells with almost no stroma, sometimes appearing to grow in cords and having a foamy appearance. (Fig. 1.)

The various malignant tumors which arise in or metastasize to the sacrum do not differ essentially in their pathology from the same tumors encountered elsewhere.

*Symptoms and Differential Diagnosis.* Ordinarily a teratoma will be discovered at or soon after birth. When intrapelvic, the symptoms are those produced by pressure and usually take the form of interference with micturition or defecation. Final diagnosis is made by the pathologist following excision.

Dermoids, on the other hand, are usually found in young women. They produce pressure symptoms and are sometimes asymptomatic. However, the cyst may become infected and

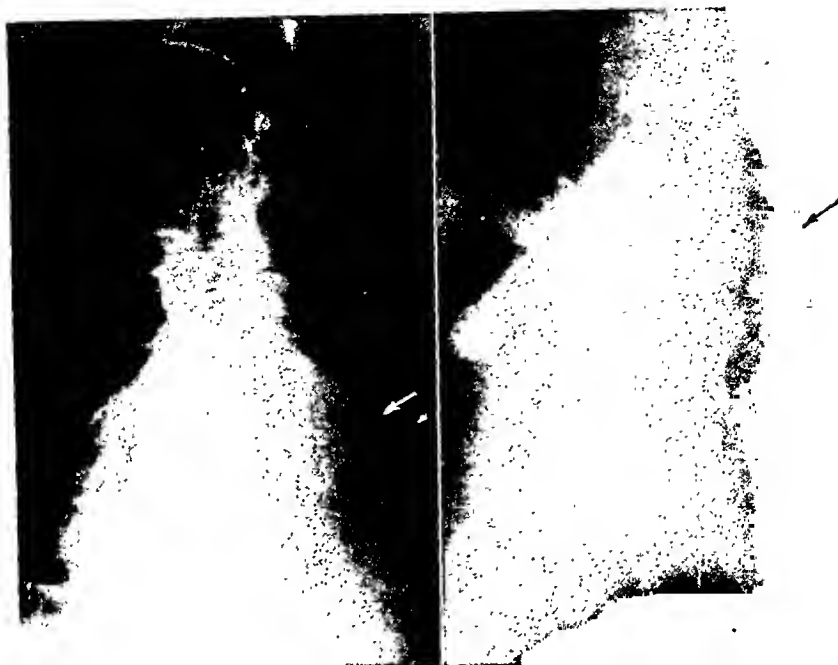


FIG. 2. Lateral x-ray showing vertebral column and upper part of sacrum; remainder of sacrum demineralized and destroyed as indicated by arrow.

FIG. 3. Lateral view; rectum outlined by barium is narrowed and displaced anteriorly by tumor. Arrow indicates area of destruction of sacrum.

consequently painful. If a dermoid becomes abscessed and ruptures externally, the patient may present a persistent blind sinus extending from the post-anal skin to the presacral space.

Predominant symptoms of chordoma are pain, constipation, a feeling of pressure, numbness or paresthesias and varying degrees of incontinence. A presacral mass and roentgenologic evidence of bone destruction are almost invariably present. In Table II a comparison is made between Mabrey's 150 cases<sup>25</sup> and the sixteen cases collected from recent literature.\*

In Table II the figures are roughly in agreement with the following exceptions: Pain and tumor were more constant factors than in the cases collected by Mabrey; constipation and a feeling of pressure were much more frequent; and complaints of numbness and incontinence are added to the list.

**Prognosis.** Dermoids rarely become malignant and can usually be extirpated without undue difficulty. Prognosis is, therefore, ex-

cellent. A good outlook for patients with teratoma may be predicted only if the growth can be successfully and completely extirpated. Many infants with teratoma do not survive the ordeal of birth and some have additional congenital malformations which affect their health. Moreover many teratomas tend to become malignant. Prognosis for the various malignant tumors is, of course, poor. A chordoma is locally malignant and has a marked tendency to recur. Although cases of metastasis from chordoma have been reported, these are uncommon. The author knows of no case of complete recovery.

**Treatment.** The treatment for all cases of presacral tumors is surgical excision whenever possible. Dermoids can usually be removed successfully and no further care is needed. Chordomas and sarcomas usually cannot be completely excised. For malignant tumors including chordoma operation should be followed by radiotherapy in each case.

#### CASE REPORTS

**CASE I.\*** F. G., a white female of fifty-seven, was admitted to Mercy Hospital on July 13, 1947,

\* I am indebted to Dr. H. E. Conly and Dr. William G. Burke for permission to report this case.

\* Actually, eighteen cases have been reported but two are omitted from this analysis because their ages (three months and five years) and the lack of bone destruction are so unusual that they throw off the statistical averages to a disproportionate degree. It is realized that this arbitrary exclusion may appear unjustifiable to some. Full details of these two cases were given by Whittaker and Pemberton.<sup>27</sup>





FIG. 4. Photomicrograph of sacrum from Case 1. Area at left is bony sacrum; at right is infiltrating adenocarcinoma.

complaining of an acute onset of abdominal pain and backache two weeks previously. These symptoms had continued and had been followed by progressive loss of control of the urinary bladder and anal sphincters and then by constipation which alternated with diarrhea.

The patient had had a uterine suspension performed in 1921. Her menstruation had ceased three and one-half years before admission and hot flashes had been noted during the past year. Eight months prior to admission she began to lose her memory and her interest in life and became emotionally unstable.

Physical examination was essentially negative except for a presacral mass approximately 10 by 7 cm. in size fixed to the pelvic wall and the right side of the anterior surface of the sacrum. The tumor was extrarectal, firm, elastic and slightly irregular. An attempt to perform a barium enema was unsuccessful because of the patient's inability to retain the barium. An x-ray of the sacrum did not reveal any definite bony destruction. Urinalysis and a complete blood count were normal. The blood urea nitrogen was 23 mg. per 100 cc.

At operation, the coccyx and lowest inch of the right side of the sacrum were removed. The major portion of the tumor was excised and the cavity packed. It was not possible to remove the entire mass. The pathologic diagnosis was chordoma. (Fig. 1.) This patient is receiving x-ray therapy.

CASE 11. L. H., a sixty-four year old white female, was admitted to Meadowbrook Hospital on January 12, 1947. Six years prior to admission the patient had had a panhysterectomy for cancer

of the fundus uteri. Following this she was apparently well for five years until she developed a pain in her lower back while shovelling. She returned to the hospital where her hysterectomy had been performed and received ten deep x-ray treatments following which she felt perfectly well until the time of the present illness. Three days before admission for no evident reason the patient developed a sudden severe pain in her lower back and was hospitalized.

Physical examination at that time revealed a fairly well nourished, adult, white female in moderate pain. She complained of pain in the neck as well as in the lower back and refused to flex the neck but would move the head slightly from side to side. Examination of the eyes, ears, nose, throat and lungs was negative. The heart was normal except for a slight systolic murmur at the apex. There was a moderate degree of incontinence of both urine and feces and slight paresthesias in the left lower extremity. I found a relaxed external sphincter, a fecal impaction which was removed without difficulty and a retrorectal mass. This mass was about the size of a half grapefruit, firm, tense and cystic. It did not invade the rectal mucosa and was fixed to the sacrum. Pelvic examination elicited no further information. The mass was aspirated through a No. 20 gauge 4 inch needle introduced just to the right of the lower end of the sacrum and 50 cc. of bloody, cloudy fluid were withdrawn. The fluid contained debris and a few leukocytes. Culture was sterile.

Neurologic examination revealed diminished sensitivity to pain and touch from the left foot to the left calf and to some degree in the perineum. Both legs were paretic, the left being worse than the right. The deep tendon reflexes were diminished. The neurologist reported that the "findings would indicate lesion of sacral segment of the cord."

X-rays revealed destruction of the third and fourth sacral segments. The roentgenologist noted that "there is so much demineralization, however, that it is difficult to delimit the extent of the destruction." (Fig. 2.) A barium enema showed the rectum to be narrow and displaced anteriorly. (Fig. 3.) Roentgenograms of the chest, head and of the cervical, thoracic and lumbar spine were essentially negative.

The patient steadfastly refused any treatment except analgesics and expired two months following admission.

Autopsy was limited to the mass which was found to be a presacral and pelvic adenocarcinoma with abscess formation and direct extension into the sacrum. (Fig. 4.) The small intestine, sigmoid and bladder were all bound down in the pelvis and there were numerous pockets of grayish pus. The sigmoid and the part of the rectum removed revealed no invading tumor tissue.

COMMENT

Although instances of metastatic carcinoma invading the sacrum exist, I have been unable to find one which so closely simulated chordoma. One hospital has had no cases in over

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TABLE III

Patient and No.	Sex	Age	Primary Source	Means of Diagnosis	Rectal
LD-43973	F	51	Breast	Clinical impression: diagnosis doubtful	No mass; no symptoms
BG-8504	M	62	Prostate	Autopsy	Tender enlarged prostate; no sacral or retrorectal mass
FK-11170	M	74	Prostate	X-ray—mottling suggestive of metastasis	Tender prostate; no retrorectal mass
SS-21905	F	61	Cervix	X-ray—"diffuse pressure atrophy"	Rectal examination not performed

100,000 admissions since 1932. A search of the records of another hospital with an active tumor service reveals that since the hospital was opened (67,769 admissions) there have been four cases of carcinoma of the sacrum, an incidence of one in 16,942 admissions. These cases are tabulated in Table III.

It will be seen at once that the diagnosis was extremely doubtful in the first and fourth cases and that no presacral mass was present in the other two. In not a single one of these cases could the diagnosis reasonably be confused with chordoma.

SUMMARY AND CONCLUSIONS

1. Sacral and presacral tumors are discussed and their rarity emphasized.

2. Analysis of eighty-one cases from recent literature plus eleven additional cases brings out the following conclusions: (1) Practically all teratomas are found in young children and are about equally divided between the sexes. (2) Dermoids occur at all ages, but the presacral dermoid in this collection of cases is limited to the female sex. (3) Bone destruction in sacral tumors is apparently limited to cases of chordoma, sarcoma and metastatic carcinoma. (4) The most common presacral tumor producing pain and bone destruction is chordoma. (5) At present there is no satisfactory treatment for chordoma. The best treatment seems to be excision whenever possible, followed by irradiation.

3. Two cases are reported, one of sacrococcygeal chordoma and one of metastatic carcinoma of the sacrum.

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#### DISCUSSION

RICHARD H. APPEL (Indianapolis, Ind.): Dr. Ross has adequately discussed the subject on which he engaged. There are, of course, many other types of tumors which we run into occasionally. At the present time we have one among our cases, a patient operated upon for adenosarcoma just anterior to the sacrum approached from the abdo-

men. Subsequently he developed a fistulous or sinus tract and then it became our baby.

These cases are very likely to fall into our hands. There is still a third type of tumor we frequently encounter from the vesication of sinus or fistulous tracts. We have a recent example of that, namely, a fistula of several years' standing. When investigated, it was found to lead to a large carcinoma which had not been diagnosed in advance, just anterior to the sacrum. I think that is frequently true of this type of disorder. We begin with the assumption that every case we see is diagnosed before surgery. That is not true. These tumors and these conditions, I think, are more primarily ours than any other of the surgical conditions of the rectum.

JAMES P. FLEMING (Rochester, N. Y.): I suppose when we think of the sacral and presacral tumors, most of our attention is focused on the dreadful chordoma, a tumor not so rare as heretofore believed. Although reported of low grade malignancy, it is not curable. I wonder if anyone has heard of or knows of a cured case of "chordoma." I know of several cases with seven-year arrests but I know of no complete cure as ever having been reported.

In making a correct diagnosis of the ventral sacral tumors, one must be most cautious as many have proved to be connected with the meninges, the so called "meningocele sacralis anterior." In several instances the tumor has been unmistakably drained of clear fluid and death has followed soon thereafter. These growths, therefore, occur as surgical surprises more often than not. They may attain large dimensions, extending upward behind the pelvic peritoneum, causing intrapelvic pressure symptoms. In cases in which spina bifida is associated, all your diagnostic resources may be taxed in making a differential diagnosis. It is sometimes difficult to decide clinically between a spina bifida sac, meningocele, myelocoele and dermoid. Differentiation must also be made between presacral tumors and fibroids, intraligamentous cysts, ischiorectal abscess, congenital dorsosacral hernia containing bowel and bladder, lymphangiomas, angiosarcomas and lipomas.

I might add in conclusion that the x-ray is a most important diagnostic aid in clearing up the diagnosis of spina bifida. I wish also to stress the necessity of early definitive diagnosis in sacrococcygeal teratomas as there is a definite risk of early malignant change. Lisco has described two cases in infants aged ten and 13 months, respectively, who developed a papillary adenocarcinoma with widespread metastasis. From a review of the literature I have found ten similar cases which seem to indicate the necessity for early treatment in this type of case.

GEORGE H. EWELL (Madison, Wis.): As Dr. Ross has pointed out, tumors and cysts of the sacro-

coecygeal region are relatively rare. The complexity of their composition has given rise to much confusion as regards their classification, mechanism of origin and the symptomatology which they may present. The explanation for the great complexity of structures lies in the fundamental embryology of the region and this same reason accounts for the vague symptomatology and the sometimes bizarre way in which these tumors or cysts present themselves.

In one case of an infected presacral dermoid cyst in a woman on whom I operated, the cyst had perforated the vaginal wall at the introitus

in such a way that the case had been erroneously diagnosed as a fistula-in-ano and on this assumption had been operated upon twice. In this instance very adequate exposure of the presacral area was obtained by using a Voelker incision with removal of the coecyx and the last segment of the sacrum; the removal of the sacral segment may or may not be necessary.

As proctologists, we should also bear in mind another type of dermoid cyst, namely, cystic teratoma of the ovary which may in rare instances perforate or communicate with the intestinal tract.



# ORGANIZATION AND OPERATION OF A DEPARTMENT OF PROCTOLOGY IN A U.S. VETERANS HOSPITAL\*

SOME EXPERIENCES GAINED FROM THE FIRST YEAR'S OPERATION

WILLIAM C. BERNSTEIN, M.D.

*St. Paul, Minnesota*

WITH the reorganization of policy for the care of veterans after World War II whereby Veterans Hospitals situated in the vicinity of medical schools were able to become affiliated with teaching institutions, the Veterans Hospital at Minneapolis, Minnesota, was one of the first to establish an intimate liaison between the active staff of the hospital and the University of Minnesota Medical School. At the present time a large number of physicians, most of whom are veterans of World War II, are taking residencies in medicine, surgery and the allied specialties and are receiving the benefits of the clinical material at the Veterans Hospital and of the teaching facilities of the University of Minnesota. Through the active interest and support of Dr. H. S. Diehl, dean of the medical school, Dr. O. H. Wangenstein, professor of surgery, Dr. W. A. Fansler, chief of proctology and Dr. J. R. Paine, chief of the department of surgery at the Veterans Hospital† a proctology service was organized and has been functioning since January 1, 1947.

The need for such a service under the supervision of trained proctologists became apparent when it was noted that many patients remained in hospital beds for relatively long periods of time for seemingly simple anorectal disorders and that there was an ever increasing waiting list of patients in need of proctologic services.

The proctology service functions as an integral part of the department of surgery. Sixteen beds were first allotted to the service and subsequently four additional beds were added. A physician who is a resident in general surgery is assigned to the proctology service for a period of three months. The resident works under the direction of the consultant in

proctology who conducts diagnostic and surgical clinics and who personally examines each patient on regular ward rounds. The resident also performs a large number of the surgical operations after having assisted the consultant on similar cases. The proctology resident is personally responsible for all histories, physical examinations and for the preoperative and postoperative care of his patients. Considering the number of patients in his wards and the relatively rapid turnover of his patients, the service has proven to be a very rugged one for the proctology resident. Each resident has, however, felt well compensated for his efforts by having gained a tremendous amount of experience in handling a type of patient that ordinarily would have received little special attention.

All types of anorectal disorders have been seen at this clinic during the past year and the four residents who have rotated through the service have had an intensive and thorough course in the basic principles underlying the diagnosis and treatment of anorectal diseases. Time has been taken regularly for chalk talks and discussion periods. Seminars in the hospital have included proctologic subjects and residents have been encouraged to familiarize themselves with the literature in this field. Several residents have written comprehensive papers on proctologic subjects while working on the service.

Approximately 1,100 complete proctoscopies and sigmoidoscopies were performed in the clinic during the twelve-month period under discussion. Due to the crowding of the existing facilities in the proctology clinic and because of the desire to permit residents on the medical service to gain experience in proctosigmoidoscopy, the medical service at the hospital has conducted its own examinations and has

† Now Professor of Surgery, University of Buffalo, Buffalo, N. Y.

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referred only those patients to the proctology clinic in whom difficulty has been encountered in examination or diagnosis.

During the year 1947 there were 499 ano-rectal operations performed. (Table I.)

TABLE I

Hemorrhoidectomy.....	237
Treatment of pilonidal disease.....	111
Treatment of fistula-in-ano.....	50
Treatment of perirectal abscess.....	23
Treatment of fissure-in-ano.....	25
Miscellaneous.....	53
	<hr/> 499

Posterior anotomy for stenosis

Surgery for pruritus ani

Excision of condylomata accuminata

Fulguration of rectal and sigmoidal polyps

Excision of hypertrophied anal papillae

Sphincteroplasty for anal incontinence

Surgical treatment of rectal prolapse

Most of the patients admitted on the proctology service have been young men who are veterans of World War II. A small number of patients are veterans of World War I and a still smaller number saw service in earlier wars.

performed in 1947. The technic for anatomic dissection as described by Fansler was used routinely with uniformly satisfactory results. We have had only four complications worthy of consideration in this paper. One patient developed a perirectal abscess three weeks following his operation; one patient had a large subcutaneous hematoma which required evacuation of the clot; another patient developed a postoperative anal stenosis which required a secondary surgical procedure for correction; the fourth patient had a postoperative hemorrhage which was severe enough to require a transfusion but in whom no actively bleeding vessels could be found when the operative area was explored. The average hospital stay following hemorrhoidectomy was five to seven days for patients living in St. Paul or Minneapolis and about ten days for patients living outside this area. Very few patients have required hypodermic medication after the day of operation and all patients have been ambulatory after the first postoperative day. Postoperative dressings have been done on all

TABLE II  
OPERATIONS PERFORMED IN 1946 AND 1947

	Hemorrhoids	Fistula	Abseess	Fissure	Pilonidal Disease	Misc.	Total
1946	121	20	10	11	60	7	222(p)
1947	237	50	23	25	111	53	499

While quite a large number of the patients were treated for recurrences of trouble for which they had been operated upon during the war, it is quite apparent that the number of recurrences seen is a very small percentage of the enormous number of patients who were operated upon during the war years. The largest number of recurrences were seen in patients with pilonidal disease. Recurrent hemorrhoids made up the second largest group. The fact that a larger number of recurrences has not been seen bears testimony to the excellent grade of work performed by our surgical colleagues in the armed forces during World War II.

#### HEMORRHOIDS

The treatment of hemorrhoids at the Veterans Hospital in Minneapolis has been entirely surgical; 237 hemorrhoidectomies were

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performed for approximately four weeks either by the resident in proctology or by the home physician.

#### PERIRECTAL ABSCESES AND FISTULAS

All acute perirectal and perianal abscesses in this clinic were treated by the uncapping or scalping operation in which an attempt is made to create a skin wound as large as the abscess cavity itself. An attempt is also made to bring the edge of the skin wound as close to the sphincter muscle as possible in order to decrease the length of the resultant fistula. No complications were encountered in the treatment of perirectal abscesses. All abscesses were operated upon as soon as the diagnosis was made. The thesis has been accepted by us that the sooner the abscess is opened, even though a considerable amount of normal tissue is sacrificed in reaching the abscess, the less will be the

damage to the anal musculature and supporting structures. In some cases of perirectal abscess it was possible to identify and remove the primary fistula tract at the time of the abscess operation. This procedure is done (1) when the tract and primary opening can be easily identified and (2) when the tract lies quite superficially so that a relatively small amount of sphincter muscle fibers need be incised.

Twenty-three perirectal abscesses were treated during 1947. During this same period there were fifty perirectal and perianal fistulas operated upon. These fistulas varied from those with a single and simple tract to those with many openings, branching tracts and deep ramifications. It has not been necessary to establish a preliminary colostomy for diversion of the fecal stream in any of these patients but it is believed that such a procedure should be carried out when the fistulectomy is to be of such magnitude that healing will be definitely retarded by the fecal stream and when a long period of anal incontinence is anticipated. No particular difficulty has been encountered in obtaining healing in any of these patients and no patients have been rendered incontinent by fistulectomy.

#### FISSURE-IN-ANO

The incidence of anal fissure in proctologic practice is higher than the figures presented here would indicate. Twenty-five patients were operated upon for anal fissure in whom the fissure was the major finding. Hemorrhoids of lesser or greater degree were removed in many of these patients while anal fissures which were co-existent in many of the patients listed under hemorrhoids were also removed. It is our belief that the proper treatment for fissure-in-ano in a clinic such as we conduct should be entirely surgical. While having a definite place in private practice, non-surgical or palliative methods in a veterans hospital would increase the load on already crowded facilities by deferring the time of surgery and by making subsequent hospital admissions necessary. The operation as performed on this service consists of (1) excision of the fissure together with associated anal skin tags and hypertrophied anal papillae, (2) elimination of associated infected anal crypts and (3) creation of a large racket-shaped wound which can be easily kept open until proper healing has taken place.

These wounds require meticulous postoperative care to avoid secondary stenosis due to scarring. No cases of fissure-in-ano were seen which were thought to be due to tuberculosis, syphilis, agranulocytosis or Vincent's infection.

#### POLYPS OF THE RECTUM AND COLON

One of the most important functions of the proctologic service is the identification of either malignant or premalignant polyps in the rectum and colon. It is our belief that cancer of the rectum and colon is best treated by preventing its development. We have adopted the belief that every patient examined on the proctologic service has potential cancer of the bowel and a thorough search is made for it. Only in this way and through the adoption of this attitude can most early lesions be discovered. We have come to be very polyp conscious and our efforts have been rewarded by frequently picking up unsuspected cases of polyposis of the rectum and colon. All benign polyps which were found in the rectum and lower sigmoid colon were destroyed by fulguration while those in the upper portions of the colon were treated by resection of the polyp-bearing portion of the colon.

In many patients with multiple polyposis of the rectum and colon in whom a complete colectomy is being considered, the decision to preserve the rectum and to destroy the polyps in this segment of bowel must rest with the proctologist. In this series of cases several young men are represented who have had ileosigmoidostomies for multiple polyposis and in whom fulguration has been carried out. These patients will have to be checked several times a year for several years and at yearly intervals for some time thereafter but the avoidance of an ileostomy or colostomy is ample reward for any inconvenience attending follow-up admissions.

#### TUBERCULOSIS

The Veterans Hospital at Minneapolis has a tuberculosis service which cares for approximately 200 patients. The proctology service has seen the tuberculous patients with rectal complications and has operated upon those who had abscesses, fissures and fistulas and who have complained of symptoms. In this group healing may have been delayed somewhat when compared with non-tuberculous

patients but satisfactory results have been obtained in all cases.

One tuberculous patient was operated upon for a large perirectal abscess. When the cavity was uncovered, it was found to be filled entirely with products of caseation necrosis which

series reveals that ninety-one patients were between twenty and thirty years of age; six were between thirty and forty and three were between fifty and fifty-five. Eighty-two patients had had spontaneous drainage of their first abscess; twenty-four of these required

TABLE III  
AGE OF PATIENTS OPERATED UPON FOR PILONIDAL DISEASE

Years	No. Patients
20 to 30	91
30 to 40	6
50 to 55	3
	<hr/> 100

resembled cottage cheese. No free pus was found. This condition is a very unusual one and is the first of this type to be encountered by us. Healing of the cavity progressed rapidly and completely.

#### PRURITUS ANI

The experience of the proctology service during 1947 has been rather unique in that relatively few veterans have applied for treatment for pruritus ani. This is in marked contrast to the experience in private practice in which approximately 25 per cent of all patients give itching as one of their chief complaints.

A considerable number of hospital patients on other services have been seen in consultation because of a complaint of pruritus ani. The policy of beginning the treatment in each case with a mild and simple therapeutic procedure and progressing to the more radical types of treatment has been followed. It has been possible in most cases to afford relief without radical therapy. Three patients were operated upon for pruritus ani using the modified Ball procedure after removing all hemorrhoids and abnormal anal crypts. The alcohol injection method as described by Buie was used in one patient. These four patients have all been benefited considerably by these procedures.

It is with no regrets that the statement is made that pruritus ani has not been one of the major problems encountered on this particular service.

#### PILONIDAL DISEASE

One hundred eleven patients suffering with pilonidal disease were treated surgically on the proctology service during 1947. A statistical survey of one hundred consecutive cases in this

TABLE IV

#### DRAINAGE PRIOR TO CURATIVE SURGERY

Spontaneous drainage.....	58	
Spontaneous plus surgical drainage.....	24	82
Surgical drainage only.....	9	
No previous drainage.....	9	
	<hr/> 100	

additional surgical drainage. Nine patients had had surgical drainage only and nine had had no previous drainage at the time of curative surgery. In this series of one hundred patients seventy-four had had no previous attempts at curative surgery. In other words previous operations consisted only of incision and drainage of abscesses. Twenty-six patients had had previous attempts at curative surgery and on these patients a total of thirty-one surgical operations had been performed. In this group of thirty-one operations fifteen had been some type of open operation and sixteen some type of closed procedure.

The modified closure method which was first described by Colp and later elaborated upon by DePrizio and others was employed in the majority of cases. This method was also advocated by Rosser in his paper on pilonidal disease which was read before the Section on Proctology and Gastroenterology of the American Medical Association in San Francisco in 1946. In each case of radical excision of the pilonidal cyst or sinus preservation of the sacrococcygeal fascia which carries the nutrient vessels to this area has been carried out. A few patients were treated by the marsupialization method of Buie. No primary closures were done in this series. Although it is too early to evaluate the final results in this group of patients, it is believed that our results to date have been very satisfactory. One patient has already been re-operated upon for recurrence. In four or five others secondary surgical procedures have been carried out to aid healing. The necessity for secondary procedures is due to poor mechanics of the healing wound rather than to infection or recurrence. We believe that more meticulous postoperative care would



have prevented delayed healing in some cases. With the exception of several extremely large and complicated cases all patients were able to leave the hospital in one to three weeks following surgical operation. A very active out-patient dressing program was carried out for all of these patients and most of them returned to their occupations soon after leaving the hospital. No difficulty has been encountered with painful postoperative scars regardless of the extent of the process and as far as it is known all patients have been able to return to their usual occupations or activities.

In view of our findings as far as recurrences are concerned it is our belief that many more cases of pilonidal disease should be amenable to a closed operation than we have been willing to concede in the past. For this reason we have reviewed the literature on the different types of closed operative procedures and find that patients who have a closed operation are usually kept on their abdomen for ten or twelve days and are given special diets to minimize bowel activity. This routine would place greatly increased demands on our nursing and dietary staffs which are already overburdened. Our pilonidal patients require a minimum of nursing care after the day of surgery and are able to help with ward work during most of their hospital stay. A full general diet is given after the day of surgery so that no special help is needed in this respect. We, therefore, will continue to use the modified closure method until general conditions permit us to adopt a procedure which requires more nursing and dietary care.

#### RECURRENT PILONIDAL DISEASE

Twenty-eight patients had had previous curative procedures. Thirty-one operations had been performed: fifteen by means of the open method and sixteen by the closed method. Twenty of these operations had been performed in the Armed Services and eleven in civilian practice.

#### CONCLUSION

The Veterans Hospital at Minneapolis is one of a large number of similar institutions situated close enough to medical teaching centers to carry on extensive teaching programs. The proctology service in every Veterans Hospital can be made a very active one. Since estimates from official sources indicate

that the Veterans Administration Facilities will not be carrying their peak load until about 1980 it is obvious that Veterans Hospitals will be a very rich source of clinical material for many years to come. It would be very wise to take advantage of this source of teaching material for residencies and fellowships in proctology. In hospitals where proctology services are organized and training programs are conducted the patient is the recipient of better proctologic care and the resident is the recipient of invaluable training and experience.

#### DISCUSSION

LOUIS E. MOON (Omaha, Neb.): I am in full accord with all of the plans that Dr. Bernstein has outlined for the management of his service as well as for the operative procedures and the care of his patients. The care as outlined should be adequate. What I want to talk to you about particularly is the opportunity that these hospitals present to teach proctology.

Dr. Bernstein today has presented concrete evidence that the facilities for teaching proctology are present in his hospital and in many other areas throughout the states. The need of a proctologic service in every surgical hospital is well known to each of you who do this type of work. The doctor has called your attention to the increasing waiting lists for proctologic service in these veterans' hospitals.

In my community I am taking care of many patients who could go to the veterans' hospital but do not. If you ask them why they do not go, they will give you three good reasons:

First, they must wait several weeks to get in. Inasmuch as rectal surgery is usually elective surgery, they are not called until the surgical department runs out of something to do. The patients cannot make any definite plans as to when they can leave their job or as to how long they will have to be away from work. Second, the patient will have to stay in the hospital from ten days to six weeks. Economically he can stay at home and pay his way and be ahead. Third, he wants to know that his operation is going to be done by someone who has had training in proctologic surgery.

With the building of new veterans' hospitals throughout the country in cities where medical schools are located, there is supposed to be an opportunity for establishing more proctologic services. We, in proctology, should have the same recognition as the other specialties, such as urology, orthopedies, ophthalmology, otolaryngology.

In order to get this recognition the proctologic service should be supervised by one who has had proctologic training and this supervision must be of the type outlined by Dr. Bernstein in his paper.

You, as proctologists, must get in there and work and train your residents. It is not enough to show a resident one or two operations and then tell the resident to go ahead and, if he gets into trouble, to call you. That is not the service that the veteran wants and that is not the type of service that will promote the establishment of residencies in veterans' hospitals. We have the opportunity in these hospitals to demonstrate that proctology should have its own department in the teaching program. Many of our members who have served in this last war will be called upon to do this proctologic surgery. Now is your opportunity to create a department for the veterans' hospital which will also be a teaching department for a medical school.

Dr. Bernstein has presented to you a well planned and well organized teaching service. Ten other hospitals have been approved for residencies and are doing the same type of teaching. The number of teaching hospitals could be doubled easily, so it is up to you who do have the teaching material to apply to the Council on Medical Education and Hospitals of the American Medical Association for permission to establish a residency.

The Proctologic Society has recognized you by making you a member. Now it is up to you to do something for the Society. Let me read again Dr. Bernstein's summary:

"The Veterans' Hospital at Minneapolis is only one of a large number of similar institutions situated close enough to medical teaching centers to carry on extensive teaching programs. The proctology service in every veterans' hospital can be made a very active one. Since estimates from official sources indicate that the Veterans Administration Facilities will not be carrying their peak load until about 1980, it is obvious that Veterans' Hospitals will be a very rich source of clinical material for many years to come. It would be very unwise to fail to take advantage of this source of teaching material for residencies and fellowships in proctology. In hospitals where proctology services are organized and training programs are initiated, the patient is the recipient of better proctologic care and the resident is the recipient of invaluable training and experience."

R. RUSSELL BEST (Omaha, Neb.): As Consultant in General Surgery for Area 8 of the Veterans Administration I should like to place a little different angle before you and acquaint you somewhat with the setup of the Medical Department of the Veterans Administration. They have four departments: General Medicine, General Surgery, Tuberculosis and Psychiatry. All surgical specialties come under General Surgery and the same is true in Medicine. There are thirteen branch areas in the country, each with a complete corps of consultants for the specialties and many of the subspecialties.

*December, 1948*

As to the organization of the proctologic service at the Veterans Hospital in Minneapolis, which is affiliated with the University of Minnesota, I had the opportunity to discuss freely the early organization of this department with Dr. John Paine who was Chief of Surgery. I encouraged Dr. Paine to set up such a service and to rotate the surgical residents through the service insofar as possible. I was very pleased when I learned that Dr. Bernstein would be in charge of this department.

I have its development very closely in view of the fact that each month I receive a report of the operations performed at this Veterans Hospital; and when I visit the hospital, I always take the opportunity to see the department. I believe it has made definite progress.

The only warning that I should like to give is that if you are going to consider establishing a proctologic service in the Veterans Hospital in your locality, please do it in a diplomatic way. The Chief of Surgery in the hospital will make the decision as to whether or not a proctologic service would be of added value to his surgical service. If you go about this undiplomatically and try to force the issue, you will be stepping on someone's toes and the service will not work out satisfactorily. Fortunately, at the University of Minnesota the service has gone along very well; and in a nearby veterans hospital at Fargo, North Dakota, which is not connected with a medical school, we have a good proctologic service.

There is another angle to consider, and I refer to the men—perhaps some of you men here—who are on full time with the Veterans Administration in proctology. If you are in this position, please never get to the place where you think you can separate yourselves from the consulting group in your area. The moment you do that you are setting the Veterans Administration program back, as I believe the key to success depends on the continuation of close cooperation and association with the general medical profession. Previous to the present regimen there were many full time doctors with the Veterans Administration who did not even belong to a medical society. I believe that most men in the Veterans Administration at this time are smart enough to know that the moment they separate themselves from the consulting group and the general profession they are separating themselves from progressive medicine, and their future will not be bright when they do that.

The remark was made that the Veterans Administration is the nucleus of socialized medicine. I do not believe that will develop; I do not want it to happen. If we go along in the proper way in our localities and communities and give proper cooperation to the Veterans Administration, I do not believe this will be such a nucleus. We cannot remove the veterans hospitals from our national program. That is impossible and wrong; but if we

do go along with the program in the correct way and help in the guidance, I believe we can keep it from developing into a socialized form of medicine for the entire population.

CHARLES POPE (Evanston, Ill.): I wish to keep my remarks confined mainly to two points paralleled by similar work in the past. First, my remarks concern pilonidal operations which, of course, can be done in many ways with a successful conclusion. It is interesting to note that the errors as far as technique are concerned were about equal in the closed procedure as in the open procedure in Dr. Bernstein's series of recurrences. This subscribes, I think, to one answer and that is that recurrence is totally dependent upon the pilonidal tissue left and not so much on the technique used. I do not care what type of excision is made; when the wound is closed if no pilonidal tissue remains, we should have no possibility of recurrence. We should always think of recurrence in that guise.

I think I may be permitted to say that at the Hines Hospital they have been using the closed procedure in most of their pilonidal cases in the last year according to the method I have described, and successfully so, according to the operator who has handled the largest number there. I believe it is running close to one hundred such cases. He

tells me he is about to publish a paper confirming the method. So while I do not think that the procedure has to be used necessarily, it is proving to be successful.

As far as any changes in technique and handling of these cases is concerned, one does not now have to keep them in bed, as long as one did during the war. Since you have fewer or no malingerers, you handle cases more comfortably and carefully, get them up earlier and do not have to give such a prolonged antibiotic and sulphonamide treatment.

I am particularly interested in another fact that should be close to our hearts, namely, that we have in the veteran's hospital as we had in the U. S. Naval Hospitals the most unusual facilities for a well organized and properly conducted proctologic service for teaching purposes. We might state further that by the good example we set before others so can we show the need for proctology. By the excellent results we obtain I hope these centers will increase.

It is an unusual situation and an example is Minneapolis set up for us with standards maybe more than we can hope for, a Veterans Hospital Proctologic Department, excellently handled and well controlled in all respects by a group of well trained men.



# PROCEDURES USED IN TREATMENT OF COMPLICATED FISTULAS

DONALD R. LAIRD, M.D.  
*Portland, Oregon*

THE complicated fistula presents a problem to all of us. No set rule applies in all cases and the principle of fitting the operation to the patient and not the patient to the operation pays dividends in reduced morbidity and improved results. I shall present a description of four procedures useful in handling complicated fistulas and shall discuss the general principles involved in their management.

A thorough knowledge of the anatomy of the rectal outlet and structures adjacent to it is necessary. The prone position is essential and capable assistants provide additional aid. Caudosacral block anesthesia is used in all cases. Low spinal anesthesia is just as effective. General anesthesia provides insufficient relaxation and it is my opinion that when general anesthesia is employed there is definitely more bleeding which hampers dissection and may jeopardize the result.

A few words about the physiology of the anus are in order. No two anuses are alike any more than two faces and bowel habits vary as widely as the personalities of patients. Careful inquiry into the bowel habits of the patient may account for the difference between a good and a bad result. For example, I would exercise extreme caution when considering the problem of incising the anal sphincter of a patient who passes frequent loose stools and who does not have well developed anal sphincter muscles. Conversely, if the patient is inclined to be constipated and passes large well formed stools, incision of a large portion of the anal sphincter fibers may be performed without much risk that control of gas and feces will be impaired. It has been my impression that the most external and medial of the anal sphincter muscle fibers exert the greatest conscious control of gas and feces. These are the fibers that have to be incised most frequently during fistulectomy. When extensive incisions of the anal sphincter are necessary, the least serious loss of control occurs when the incision is made

directly through the posterior portion of the anal musculature; and the greatest loss of control is produced when the anal sphincters and transverse perineal muscles are incised anteriorly. This is especially true when this procedure is carried out in women.

Occasionally I have seen a patient who has had a third degree laceration of the perineum during childbirth followed by a repair which has resulted in complete loss of control of flatus and serious loss of control of feces. Figure 1 represents the result of healing of a third degree laceration of the perineum. A deep sulcus through the perineal body is shown; the widely separated ends of the torn anal sphincter muscles are attached to the margins of the scar. The following reparative surgical procedure is performed.

## OPERATION FOR RELAXED SPHINCTERS

A rectangular flap of skin 4 cm. wide is dissected free beginning at the posterior vaginal fourchet and is extended to the anal verge. (Fig. 2.) As the dissection approaches the anal verge, the tissue flap is increased in thickness to about  $\frac{1}{8}$  inch to insure adequate blood supply. If the cut surface of the flap bleeds easily, dissection is extended further into the anal canal keeping the thickness of the dissected flap at about  $\frac{1}{8}$  inch. If the blood supply is deemed inadequate, the thickness of the dissected flap may be increased by including more sphincter and rectal wall muscle fibers in the flap. The blood supply of this flap must be adequate for tissue viability even in the presence of some infection. If the anus is extremely relaxed, it may be necessary to remove a wedge of tissue from the perineal body. The deep sulcus thus formed is then closed with one or two layers of vertical mattress sutures of No. 0 chronic catgut or No. 20 cotton suture. Too many sutures should not be used and they should not be tied too tightly as the maintenance of the blood supply of the tissues is important. The skin flap is

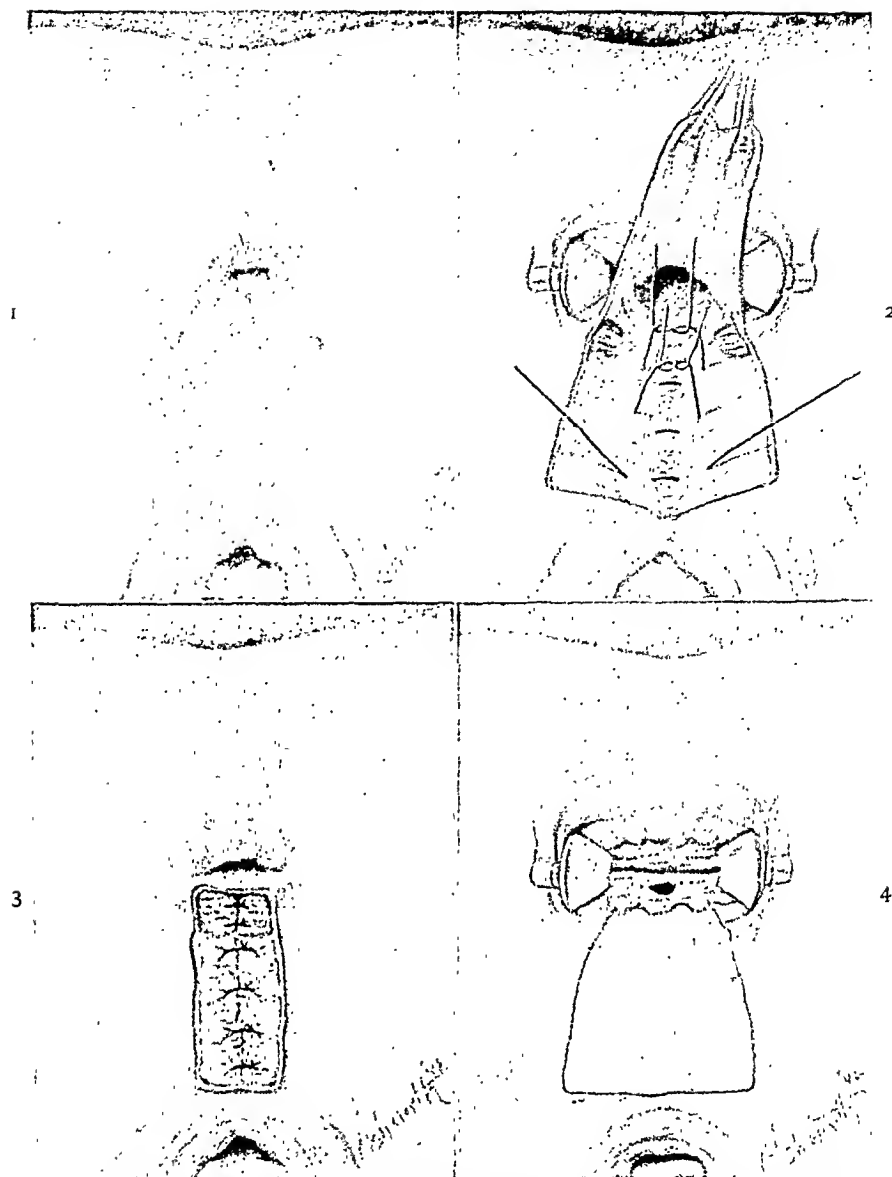


FIG. 1. Shows the healed result of a third degree laceration of the perineum. The retracted ends of the anal sphincter muscles are attached to the scarred surfaces of the deep sulcus.

FIG. 2. Represents the dissection of a wide skin flap over the sulcus. The flap dissection has been extended into the anal canal. The ends of the anal sphincter muscles are left attached to the walls of the sulcus. The first layer of sutures used to close the sulcus is shown.

FIG. 3. Shows the second layer of sutures which completely closes the sulcus and approximates the ends of the anal sphincter muscles. A viable flap of anal mucosa and skin prevents rectal discharges from infecting the deeper part of the sulcus. The skin is not closed.

FIG. 4. Represents a rectovaginal fistulous opening and the line of incision in the skin for the dissection of the flap.

trimmed even with the anal verge and no attempt is made to suture the cut edges of skin over the perineal body. Figure 3 illustrates the finished operation and shows the second layer of mattress sutures which completely closes the sulcus and approximates the ends of the anal sphincter muscles, thus tightening the anus. A viable flap of anal mucosa prevents rectal discharges from infecting the deeper parts of the sulcus. The skin is not closed.

I have successfully used this procedure about twice a year since 1940 for patients having loss of anal sphincter control following third degree perineal lacerations or following extensive fistulectomies.

#### MUCOSAL FLAP OPERATION

We have all seen women with rectovaginal fistulous tracts in extremely thin-walled, rectovaginal septa on whom previous attempts have been made to close the tract by the vaginal route with the result that the fistula became enlarged after each attempted repair. It is in this type of fistula that the sliding mucosal flap with or without a muscle plug may be used. Figure 4 represents this condition and shows the line of incision in the skin of the perineum beginning  $1\frac{1}{2}$  inches anterior to the anal verge being carried into the anal canal and on either side of the primary opening in the rectal mucosa.

Figure 5 shows the dissection of the flap which is composed of skin, rectal mucosa, submucosa and circular fibers of the anorectal wall. The rectovaginal fistulous opening has been closed by two sutures after the margins of the opening have been trimmed free from epithelium. The dotted line indicates the line of amputation of the flap which has been dissected free from the rectal wall 3 to 4 cm. above the rectovaginal opening. After amputation of the excess tissue of the flap its proximal margin is fixed to the sphincter musculature at the level of the dentate margin and held there by interrupted suture.

Extreme care must be exercised to prevent trauma to tissues. The operative result will be jeopardized by tearing the mucosa, by dissecting the flap so thinly that the blood supply is impaired or by suturing the flap to the anal musculature in a manner that puts the suture line under tension.

Figure 6 represents the finished operation. The flap which should include mucosa, sub-

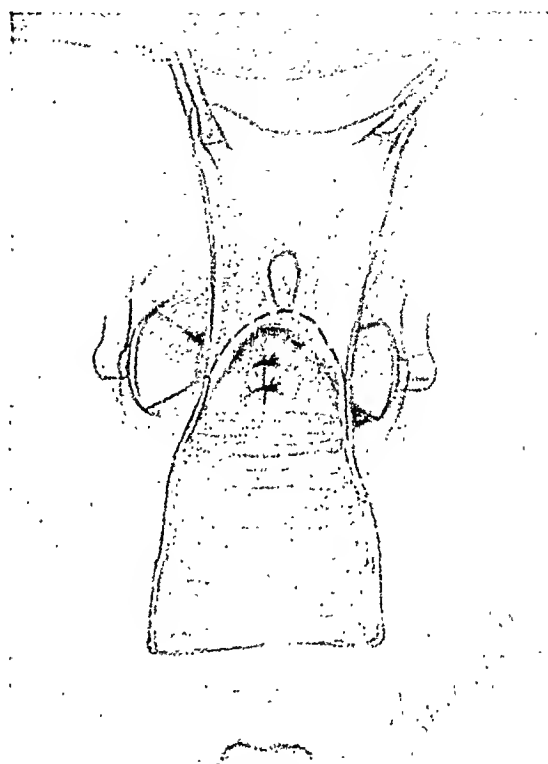


FIG. 5. Shows the dissection of the flap of tissue composed of skin, rectal mucosa, submucosa and circular fibers of the anorectal wall. The rectovaginal fistulous tract has been closed by two sutures after the margins of the tract have been trimmed free from epithelium. The dotted line indicates the line of amputation of the flap.

mucosa and some circular fibers from the rectal wall has been retracted caudally and sutured to the anal sphincter muscles at the level of the dentate margin.

I have found this procedure completely successful in patients who have relatively thick rectovaginal septa and rectovaginal openings 1 cm. in diameter or less.

#### MUSCLE PLUG PROCEDURE

For patients who have thin-walled, relatively avascular, rectovaginal septa and rectovaginal openings over 1 cm. in diameter I have used a living muscle plug dissected from the rectal wall to close the opening. (Fig. 7.) I have been unable to find in the literature any reference to this means of closing large fistulous openings. It is rarely necessary to utilize this procedure but under the circumstances illustrated by the following report I am certain it was the only means of achieving a good result.

Mrs. R., an eighty-eight year old obese woman, who had had a severe coronary attack four years previously, was first seen on September 3, 1946.

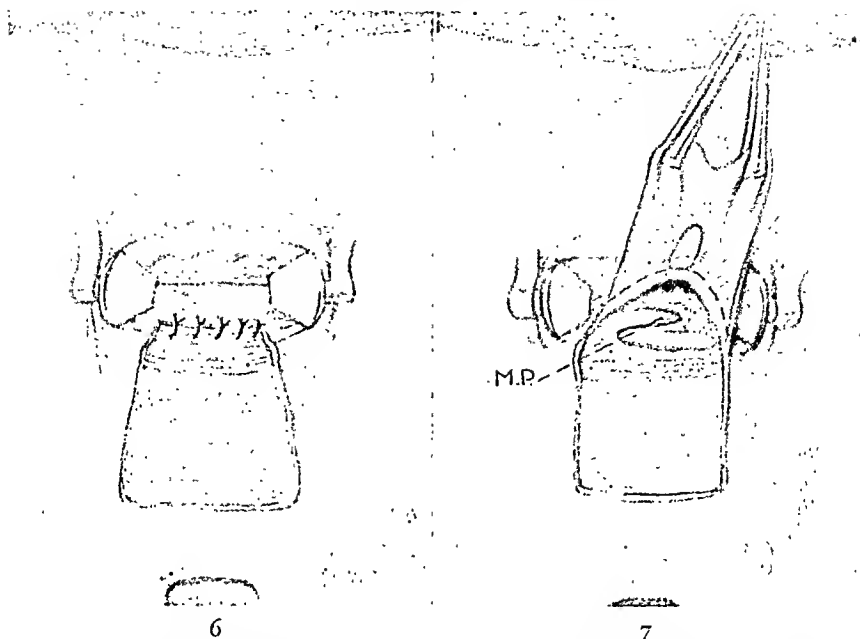


FIG. 6. Represents the finished operation. The mucosal flap which should include submucosa and some circular muscle fibers from the rectal wall to insure adequate blood supply has been retracted caudally and sutured to the anal sphincter muscles at the level of the dentate margin.

FIG. 7. Illustrates the muscle plug (MP) filling the large fistulous tract. The dissected flap which is composed of rectal mucosa, submucosa and some circular fibers of rectal musculature has been dissected free from the rectal wall for a distance of 4 to 8 cm. superior to the rectovaginal primary opening. The flap is amputated at the level of the dotted line and the flap is then sutured to the anal sphincter musculature at the normal level of the dentate margin as shown in Figure 6.

At that time I discovered an ulcerating adenocarcinoma 4 by 5 cm. in diameter on the left anterior anorectal wall which involved the anal sphincter and the vaginal wall. Owing to her advanced age, the previous coronary attack and crippling arthritis, an excision of the left anterior rectal wall, the involved anal sphincters and vaginal wall was performed. The defect in the vaginal wall was closed. Due to poor blood supply and a thin rectovaginal septum, a rectovaginal fistula 2 cm. in diameter resulted.

On August 20, 1947, almost one year after the local resection, examination did not reveal evidence of a recurrence of carcinoma; but when the patient strained during defecation, rectal mucosa and the rectal wall prolapsed through the relaxed anal sphincters. The rectovaginal fistula was located 5 cm. above the anal verge in the left anterior rectal quadrant and would admit my index finger. The rectovaginal septum was extremely thin and relatively avascular.

The dissection was carried out as illustrated in Figures 4 and 5. The redundant, thickened mucosa and submucosa of the anterior two-thirds of the rectum were dissected free for a distance of 8 cm. internal to the dentate margin and a cuff of redundant rectal mucosal and submucosal tissue 4.5 by 7 cm. was excised. The rectovaginal fistulous

margins were freed from epithelium and a piece of rectal wall muscle which had excellent blood supply was drawn from the rectum through the rectovaginal opening and held by suture placed in the vagina as illustrated in Figure 7. The flap was amputated at the level indicated by the dotted lines and was then sutured to the anal sphincter musculature as shown in Figure 6.

Thus far I have discussed only instances in which large fistulous openings were situated at or internal to the dentate margin anteriorly. The same principles and procedures previously described are just as applicable when the primary fistulous openings occur laterally or posteriorly. I mention the use of the seton only to condemn it. Up to the present time I have not seen a fistula which could be handled better by surgical procedures similar to the ones just mentioned rather than by employing a seton.

#### MOBILIZATION OF THE RECTUM FOR COMBINED RECTOVAGINAL AND RECTO-URETHRAL FISTULAS

The final procedure which I have called "the mobilization operation" is useful in treating

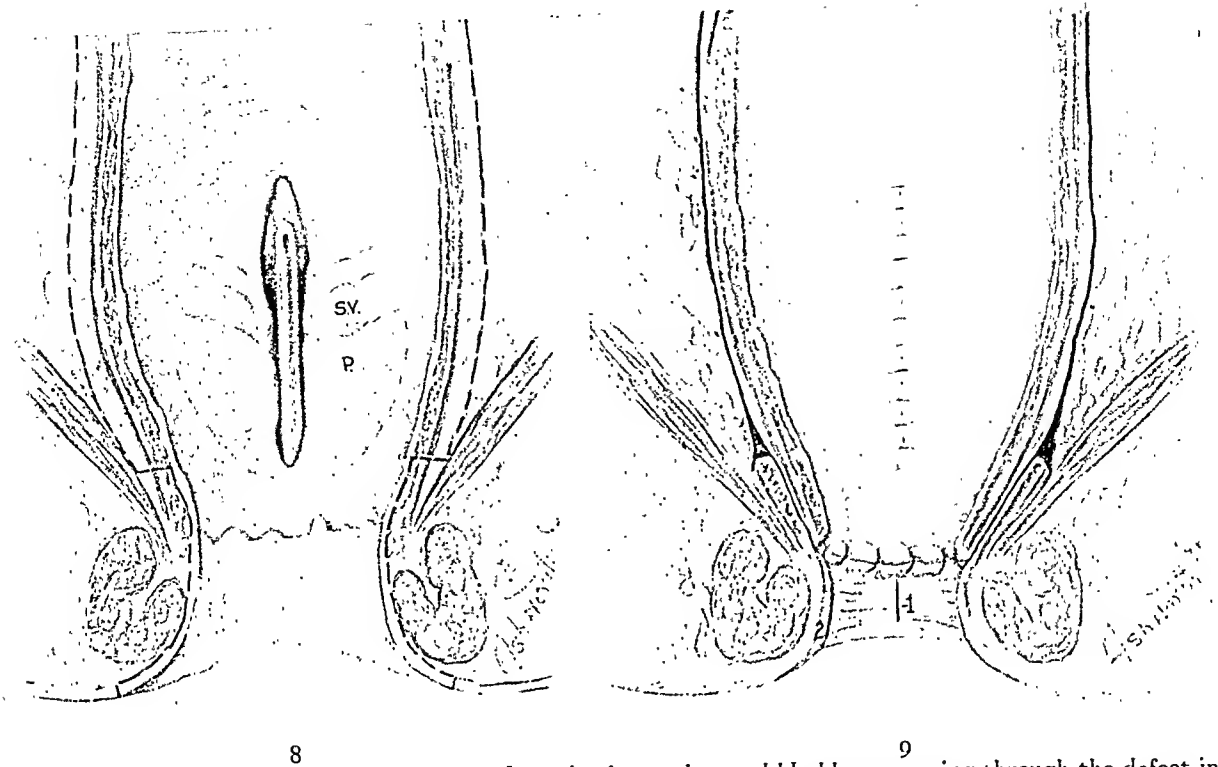


FIG. 8. Semidiagrammatic sketch shows the catheter in the urethra and bladder appearing through the defect in the anterior rectal wall. The position of the prostate (P) and seminal vesicles (SV) are indicated by slight shading. The dotted lines indicate the planes of dissection for mobilization of the rectum. The anal and perineal skin (S) of the anterior half of the rectum has been removed as depicted in Figure 7.

FIG. 9. Illustrates the position of the rectum after mobilization and the removal of the segment of rectum containing the defect in the anterior rectal wall. The horizontal lines in the long axis of the anterior rectal wall represent the sutures which close the defect in the bladder and prostatic capsule now covered by the intact mobilized segment of rectum which has been pulled down and sutured to the anal sphincter musculature. The vertical line in the sphincter musculature anteriorly (1) indicates the line of incision in the anal sphincter muscles performed for the double purpose of obtaining adequate exposure and drainage.

combined rectovesical and recto-urethral fistulas. A brief history of one of these patients may be valuable.

A man, aged sixty-three years, was first seen by me March 19, 1947, at the hospital. In 1942 he had a suprapubic prostatectomy. Since that time he had passed all urine per anum and frequently passed flatus and feces through his penis. During the six weeks previous to my first examination there had been two unsuccessful attempts to close a large combined rectovesical and recto-urethral fistula. The patient was emaciated and acutely ill.

A urethral catheter was in place and feces and gas could be seen passing into the urine bottle at his bedside. Digital examination revealed a stenosed anus, and a urethral catheter could be directly palpated through a large defect in the anterior rectal wall. A sigmoidoscope could be passed directly into the bladder. A partially healed incision over the transverse perineal muscles was present. Figure 8 represents the essential findings and the dotted lines indicate the planes of dissection.

Mobilization is begun by dissecting an anterior skin flap as in the previously described procedures. The dotted lines in Figure 8 indicate planes of dissection. Dissection is carried up into the rectum over the anterior three-fourths of the anorectum until it is well above the insertion of the levator ani muscles before the full thickness of the rectal wall is penetrated. The anus is dilated and the sphincter musculature is incised anteriorly to gain exposure for mobilization of the rectum. The margins of the proximal rectum are grasped by forceps and the rectal wall is freed from the prostate and seminal vesicles by sharp dissection. Blunt dissection is used laterally and above the prostate. Dissection laterally should be extended as high as possible and the lateral ligaments of the rectum usually to be divided. Dissection anteriorly necessarily must stop where the peritoneum of the rectovesical pouch is firmly attached to the rectosigmoid which is usually 10 to 11 cm. above the anal verge. In



the patient just mentioned the peritoneum was rather thick and it peeled from the posterior bladder wall rather easily, which allowed the rectum to be retracted caudally further than is usually possible. Extreme care and usually blunt dissection in this region is necessary to avoid damage to the posterior bladder wall and ureters. It is at this stage of the dissection that caudosacral anesthesia is appreciated.

After the rectum has been mobilized as completely as possible the bladder and prostatic epithelium which had grown into the defect in the prostatic capsule and bladder is trimmed away and the defect is closed by interrupted chromic No. 0 sutures. A No. 30 urethral retention catheter is left in the bladder. Cystotomy was not done in this instance.

Figure 9 illustrates position of the rectum after mobilization and removal of the segment of rectum containing the defect in the anterior rectal wall. The numeral (1) indicates the line of incision in the anal sphincter musculature performed for the double purpose of obtaining adequate exposure during operation and for drainage postoperatively. The horizontal lines in the long axis of the anterior rectal wall represent the sutures which close the defect in the bladder and prostatic capsule which is now covered by intact mobilized segment of rectum which has been pulled down and sutured to the sphincter musculature with non-absorbable suture. Actually considerably deeper bites are taken than is shown by the drawing.

One-half inch Penrose drains are placed laterally to drain the supra levator spaces.

Postoperatively this patient received two transfusions and 100,000 units of penicillin at three-hour intervals for a period of two weeks. The Penrose drains in this patient were removed on the fourth postoperative day and the catheter on the twenty-first day. After the removal of the catheter the patient had no difficulty with control of his urine and he gained 20 pounds during the two months following his operation. By September, 1947, he was having a daily formed stool 2 cm. in diameter. His control of flatus and feces was excellent. Examination revealed a slight mucosal ectropion on the left side of the anus.

This procedure of mobilization of the rectum and the removal of a segment has been successfully used twice for conditions identical with the case just described: once for rectal prolapse accompanied by carcinoma, once for extensive adenomatous hyperplasia involving the entire

lower rectum and once for stricture of the mid-rectum which followed fulguration of carcinoma.

For the past nine years I have used the aforementioned procedures successfully. I realize that what has been described may have been done previously by some but I have failed to find descriptions in the literature.

#### DISCUSSION

JULIUS B. CHRISTENSEN (Omaha, Neb.): I will agree with Dr. Laird that sacral or spinal anesthesia is very helpful in surgical treatment of complicated fistulas; but while he insists on the prone position, we operate upon them in a left Sims and probably many of them are done in lithotomy. The author's observations of the differences in musculature of the anus and perineum of these cases is interesting. I do not recall any special studies having been made, but I am sure we all have been guided in our handling of cases of fistula by our evaluation of development of the individual and inquiry as to their bowel habits.

The mucosal flap operation for correction of rectovaginal and vesicular fistulas is successful. Dr. Laird has given the steps in its performance. The procedure of dissecting the mucosal flap and the careful handling of it is the key to success. The flap must be more than mucosa thick. The larger it is, the more submucosal and muscle tissue should be mobilized. The tissue must survive trauma, infection and constriction. Never enlarge a small flap by stretching or thinning it. Apply your "T" forceps to the lower edge only and resect this devitalized tissue before suturing. One careless application of a hemostat on the flap may cause the tissue to break down and the fistula will recur. It is so important that the operation be a success that I denude the anal margin in that quadrant about 1 cm. below the dentate line and suture the flap to this lower level.

I question the necessity of always closing the tissues of the vaginal wall. This is often difficult to perform and always seals up blood, serum and potential infection beneath your mucosal flap. In these cases we have had success leaving this defect open to granulate.

Mobilizing a plug of muscle tissue is new to me, and I believe it could be helpful in case of a large defect. I expect that any muscle would in time be replaced by fibrous tissue.

We still use a seton in the treatment of very complicated anal fistulas. When operating upon a fistula in multiple stages attempting to preserve the sphincter muscle, the seton is helpful in providing drainage and easy identification of the remaining tract. We do not use it on any of the types of cases discussed in this paper.

The urologists were the first to attempt the cure of urethrorecto fistula. It is interesting to note that

they described the opening in the rectum as viewed through the cystoscope, and a proctologist looked into the bladder with a proctoscope.

Drs. Hugh Young, and Harvey Stone, in Baltimore, reported three cases in 1913 treated successfully in this manner, and four years later eight more with one failure. Others have since reported similar success with only minor changes in bladder drainage, preparation and chemotherapy. A point of practical importance is to begin the dissection of the mucosa in the posterior quadrant. It is easier to find the plane of cleavage here and this area is free of scarring and infection. More bleeding will be encountered about the fistula opening which is best approached from either side. The dissection must go well above the fistula opening to enable the bowel to be sufficiently prolapsed to resect the fistula. We cure the fistula and end up with a colostomy planted in the anal sphincter, but it is still a good operation for this very distressing condition.

R. J. JACKMAN (Rochester, Minn.): I shall confine my remarks to two phases of Dr. Laird's paper: (1) the factor of "rectal incontinence" and (2) "low-lying" rectovaginal fistulas.

The surgeon's fear of producing rectal incontinence is responsible in many instances for inadequate or incomplete surgery in operations for fistula, and thereby he is actively promoting what he is trying to avoid. The infection in the tissue continues to spread, producing scar and destroying or immobilizing muscles, so that many patients with extensive fistulas who have never had any surgical treatment or perhaps inadequate surgical treatment have a variable degree of incontinence.

The term "rectal incontinence" is a relative one and the degree of incontinence is dependent on many factors, such as the consistency of the stool as well as the intelligence and personality structure of the individual. On one extreme is the patient with a perineal colonic stoma, who objectively is completely devoid of anal muscular control but who subjectively reports that his control is good. This patient, in his own mind, rationalizes that his life has been spared because a rectal cancer was removed; hence, any subjective evidence of incontinence or whatever difficulty he might have is placed in the background. On the other extreme, the fastidious patient, who may have a post-operative fistulotomy sulcus through which a little mucus leaks, may be extremely unhappy.

To me, therefore, one of the biggest factors in determining which patient may or may not have rectal incontinence is an analysis of his mental make-up as well as history relevant to the nature of his bowel habits. Deferred or inadequate surgical treatment promotes incontinence. Prolonged post-operative packing of fistulotomy wounds should be avoided because it promotes formation of a wide

block of scar which acts as a mechanical impediment to satisfactory functioning of the anal sphincter.

Dr. B. T. Daniels, a graduate student in surgery in the Mayo Foundation, has given me permission to use unpublished figures arrived at in the development of his thesis on rectovaginal fistulas. Daniels found that in a forty-year period (1907 to 1947) only 554 patients (exclusive of those who had congenital rectovaginal fistulas) had been to the Mayo Clinic with rectovaginal fistulas of all types and due to many different causes. Fortunately, rectovaginal fistulas are relatively uncommon; they probably constitute less than 5 per cent of all anorectal fistulas.

One group of the 258 patients treated surgically was large enough to permit statistical analysis. This group consisted of patients who had "low-lying" small fistulas; that is, those fistulas with a diameter of up to 5 mm. and with a rectal source at or near the dentate margin and a vaginal source at or just inside the posterior fourchet. The condition of ninety-seven patients in this group was followed. The fistulas of twenty-four of these ninety-seven patients were caused by some anorectal inflammatory process. Fifty-two fistulas were the result of childbirth lacerations and the remaining twenty-one had occurred because of numerous miscellaneous causes, including perineorrhaphy, hemorrhoidectomy, chronic ulcerative colitis, trauma and vaginal reconstruction. Several had no known cause.

Twenty-six of these patients with low-lying, small fistulas were treated by some sort of plastic operation which included such procedures as (1) a simple layer separation and repair of the defect after excision of the fistula, (2) inversion of the tract into the rectum followed by excision after purse-string suture of the defect or (3) some modification of the mucosal flap type of operation described by Dr. Laird, also known as the "Elting" or "Noble" operation. Thirty-eight per cent of these patients had recurrences.

For fifty-seven of these patients with low-lying small fistulas the same sort of plastic repair previously mentioned was carried out but, in addition, perineorrhaphy was done. The recurrence rate in this group was 40 per cent.

The remaining fourteen patients in this group which had low-lying small fistulas were treated by an unroofing operation. Only two, both of whom had chronic ulcerative colitis, had a recurrence. The recurrence rate here was 9 per cent.

In conclusion, we can state that (1) rectovaginal fistulas are relatively uncommon and (2) failures after surgical treatment are numerous and the type of procedure used should be fitted to the patient depending on the location, size and cause of the fistula. Probably the most satisfactory

procedure in the treatment of low-lying rectovaginal fistulas is the simple unroofing operation, with immediate or, in some instances, subsequent perineorrhaphy after the infection has subsided.

In most instances of low-lying rectovaginal fistulas, it is our opinion that the same principles of surgery hold as apply in other anorectal fistulas; that is, conversion of the fistulous tract into an open wound ("unroofing operation"). This may be sufficient to take care of the problem. If it is believed that perineal repair should be done, in many instances it is better to do this at a later stage, after infection has subsided and blood supply has improved. In either event, in the performance of perineal repair all sphincter muscle resistance and overhanging ledges distal to the rectovaginal fistula should be eliminated by not suturing the inner or medial part of the anal sphincters; thus, the patient will be temporarily incontinent, but as the scar forms, the muscle ends gradually will be pulled together.

HOWARD K. BELNAP (Ogden, Utah): Last year at Atlantic City Dr. Laird described this third operating procedure to me. Upon his recommendation I operated upon a patient who a year previous had had radium inserted in the cervix for treatment of carcinoma. As a result of this radiation she developed a radiation proctitis that resulted in a stricture of the rectum at the level of the cervix with a sloughing of the rectovaginal wall both above and below the stricture, resulting in rectovaginal fistulas. Both of these were large enough to admit the index finger.

The operation as described by Dr. Laird gave no trouble except there was considerable bleeding

from the right middle hemorrhoidal artery which was a little difficult to control. The end results were excellent, the patient having complete control of her bowels and there has been no recurrence of the fistula.

I believe that this procedure has two definite advantages: (1) There is no suturing of the rectal wall through which a possible fistula may occur; (2) it restores the normal lumen of the rectal area to the bowel.

DONALD R. LAIRD (closing): I want to thank Dr. Christensen, Dr. Jackman and Dr. Belnap for their discussion. Dr. Christensen mentioned that he did not use the prone position in his operative work. I am sure that in the mobilization operation he would find the prone position a great aid. In repairing rectovaginal fistulas Dr. Christensen also leaves the vaginal side open to allow for drainage of serum or pus which might develop.

Dr. Jackman mentioned that rectal incontinence is due mainly to the mental make-up of the patient. This certainly is true and it is possible to minimize greatly the number of complaints of incontinence by carefully explaining to patients what to expect as a result of their operation. If the patient is not told how his rectum will feel after surgery and how it will function, the patient will think that because his anus does not feel or function the same after surgery as it did before something went wrong at surgery or that the wound is not healing properly. If, however, patients have been told in words that are plain what to expect when a portion of the sphincter muscles have to be incised, it makes them very much easier to live with. It pays to take this time and trouble.



ONE YEAR'S TREATMENT OF NON-SPECIFIC ULCERATIVE COLITIS WITH INTESTINAL EXTRACT\*

BENJAMIN HASKELL, M.D. AND M. H. F. FRIEDMAN, PH.D.  
Philadelphia, Pennsylvania

AS reported elsewhere,<sup>1</sup> we entertained the possibility that non-specific ulcerative colitis is due to a deficiency of an

which has elapsed since treatment was begun has been too short to permit evaluation of the results. The present report is, therefore, re-

TABLE I

Duration of Symptoms:	
Less than 1 yr.....	8
1 to 3 yr.....	14
More than 3 yr.....	5
Bowel Segment Involved:	
Rectosigmoid only.....	9
Rectum to hepatic flexure.....	8
Whole colon.....	7
Indeterminate*.....	3
Bowel Movements:	
Marked diarrhea.....	13
Intermittent diarrhea.....	7
Formed stool regularly.....	3
Constipation.....	4

\* Rectosigmoid involved but upper limits of disease process not determined.

intrinsic protective factor which is present normally in the bowel mucosa. This view would bring into accord a mass of apparently conflicting evidence.

In March, 1947, we<sup>1</sup> summarized the results of short term treatment with extracts of hog's intestinal mucosa in a small series of patients suffering with non-specific ulcerative colitis. After our study had been in progress for several months, our attention was directed to similar experiments conducted by Gill<sup>2</sup> in England. Improvement was shown by twelve of his eighteen patients who had been fed large amounts of either raw or dried preparations of pig's small intestine. The maximum beneficial effects were obtained only on continued treatment with the intestinal substance. Gill believed his results indicated that ulcerative colitis could be attributed to the lack of some factor which is produced in or by some portion of the small intestine. A similar concept that ulcerative colitis is in the nature of a deficiency disease was also advanced by Brown<sup>3</sup> in 1925.

To date we have treated seventy-one patients, but in most cases the time interval

TABLE II

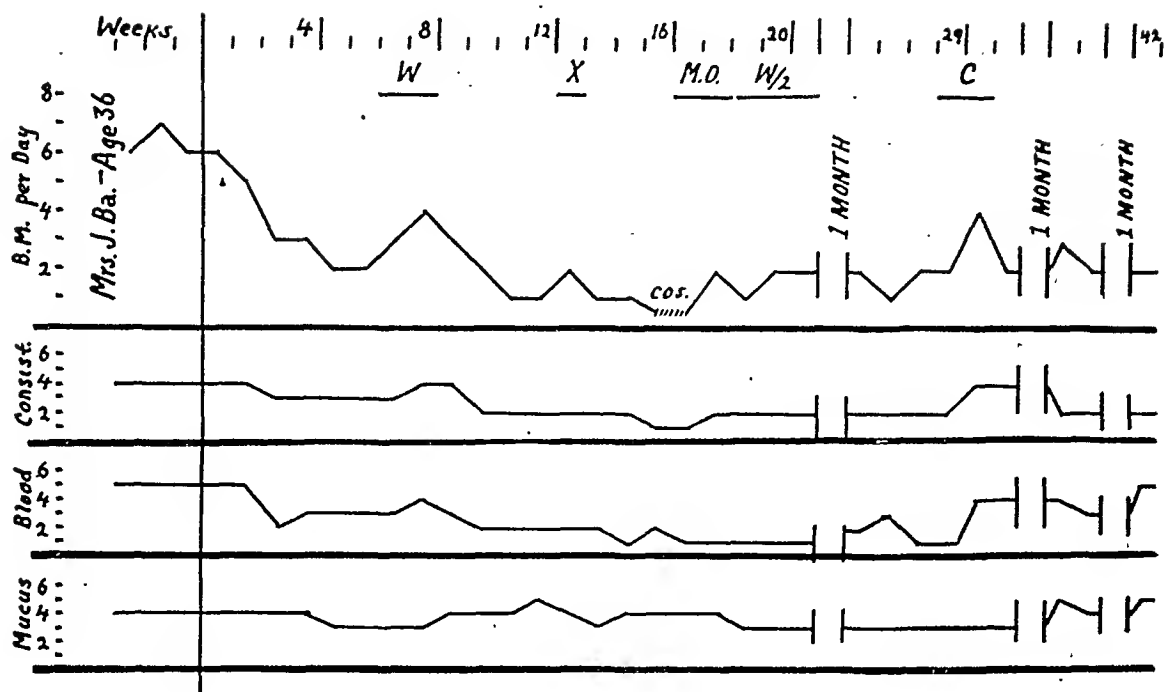
Index	Stool Liquid	Blood Present	Mucus Present
5	Each B.M.* every day	Each B.M. every day	Each B.M. every day
4	Some B.M. every day	Some B.M. every day	Some B.M. every day
3	Some B.M. some days	Some B.M. some days	Some B.M. some days
2	None	Uncertain	Uncertain
1	Costive	None	None

\* B.M.—bowel movement.

stricted to a study of twenty-seven patients who have been under treatment for a minimum period of one year. (Table I.) Included in this group are eight men and nineteen women whose ages range from sixteen to fifty-seven years. Several patients presented histories suggesting that the onset of the disease occurred as long as fifteen to twenty years prior to commencement of this study, but the longest period of illness actually confirmed by our own clinic records was thirteen years. Six women patients were ill enough to require hospitalization at the time treatment with intestinal extracts was instituted, and at least three of these had been admitted to the hospital for surgical treatment. With the exception of one patient with two small polypi in the rectal ampulla, none of this group of twenty-seven showed polypoid degeneration. Two patients had an associated arthritis and one had a moderate intermittent erythema nodosum.

Diagnosis in each case was established on the basis of clinical history, sigmoidoscopy, roentgenologic bowel studies, examination of the stools and repeated stool cultures which were negative for pathogenic organisms. The

\* From the Proctologic Division of the Department of Surgery and the Department of Physiology, Jefferson Medical College and Hospital, Philadelphia, Pa. Aided by a grant from Wyeth, Incorporated. The following have participated in this investigation: Drs. J. D. Allen, W. J. Snape and J. M. Waldron.



W—extract withdrawn

X—husband hospitalized for surgery

Cos—patient costive, defecation uncomfortable

MO—mineral oil taken

W/2—extract reduced to one-half previous dose

C—severe upper respiratory tract infection

FIG. 1. Mrs. J. Ba., age thirty-six, suffered with non-specific ulcerative colitis for three and one-half years. Extract administered at point indicated by vertical line. Except during periods marked "W" and "W/2," the dosage level ranged from 75 to 40 Gm. per day. About the fortieth week the patient complained of severe anal pain. Examination revealed a bleeding anal fissure. Sigmoidoscopic examination showed the mucosa to be practically normal except for a small granular area about 1 inch above the anorectal line. The indices for the ordinates are explained in the text.

same criteria were used for evaluating the results of treatment. Sigmoidoscopic examination of the bowel mucosa was made at intervals

TABLE III

## Evidence of Improvement:

Symptomatic and sigmoidoscopic.....	13
Sigmoidoscopic only.....	8
Symptomatic only.....	3
No improvement noted.....	3

and roentgenographic studies of the colon following barium enema also were conducted. Daily records included the frequency of bowel movement, consistency of the stool, presence of blood and mucus, occurrence of pain, dates of menstrual flow and the presence of upper respiratory infections. An attempt was made to grade the severity of the bowel symptoms by the adoption of numerical indices for consistency of the stool, presence of gross blood and presence of mucus. (Table II.)

The procedure employed for preparation of the intestinal extract used in this study is described elsewhere. From 50 to 100 Gm. were

administered daily in divided doses. The material was provided either as a powder or in a granular form. Treatment continued for several months at this dosage level and was reduced or withdrawn when improvement was well marked. Placebos consisted of either enteric-coated lactose tablets or a dried preparation of powdered meat and casein with a protein content equivalent to the extract.

## RESULTS

The results of this study are summarized in Table III and the progress of a typical case is shown in Figure 1. The two most striking signs of improvement were the decrease in the frequency of bowel movements and the disappearance of gross blood from the stool. In patients in whom frequency of defecation was not a marked symptom the disappearance of blood was the first noticeable sign of improvement. The mucus content of the stool was also greatly reduced during treatment, the decrease roughly paralleling the decrease in gross blood.

In general, improvement was first noted after two to five weeks of treatment with intestinal extracts. In patients with illness of less than one year's duration the improvement was more prompt than in patients ill two or more years. It is possible that a more prompt therapeutic response might have been obtained if the extract had been administered in larger doses.

It has been observed commonly in chronic ulcerative colitis that an exacerbation frequently follows respiratory tract infections. In the present series nearly all patients suffered acute colds during the year and in most of them a flare-up of symptoms resulted. However, the bowel symptoms appeared to be less intense and subsided sooner than on previous occasions. Several patients who experienced mild exacerbations during each menstrual period reported a diminution of these periodic symptoms following the use of intestinal extract.

Sigmoidoscopic evidence of healing followed an interesting and somewhat unexpected pattern. Symptomatic improvement occurred in nearly every instance before well defined reparative changes appeared in the bowel mucosa. Sometimes this interval was as long as one month. The first change noted was a decrease in friability. This was later followed by healing of the ulcers and a slow disappearance of the diffuse granular changes. The mucosal improvement began at the proximal limits of the diseased area and gradually extended caudad. This was evident on direct sigmoidoscopy or by barium enema study in those cases with involvement above the lower sigmoid. The rectum was the last area to heal. Some degree of tenesmus persisted in several patients even though the number of stools had been reduced to one or two per day. This symptom was present as long as the lower rectal mucosa showed inflammatory change.

X-ray findings yielded little additional information in most of the patients with the disease processes limited to the rectum and lower sigmoid. It is well known that lesions in this area may show no radiologic changes from the normal.<sup>4</sup> Patients with extensive involvement of the colon showed roentgenologic evidence of improvement in only three instances. In six other patients who were severely ill no marked changes have been noted as yet. The advanced fibrosis present in severe cases may not be reversible even when there is

evidence of mucosal healing and symptomatic improvement.

#### COMMENT

Lesions of the colon which have been produced experimentally are of an acute nature and heal rapidly without becoming chronic.<sup>5</sup> In the absence of an animal assay method, standardization of potency must be carried out upon patients with the disease. Non-specific ulcerative colitis is a chronic disease showing periods of remissions and relapses which appear to be spontaneous. In most cases a distinct psychogenic factor<sup>6</sup> also appears to be present. Consequently, one might expect a certain number of patients to show some response to non-specific therapy. The efficacy of therapy can be determined only by rigidly controlled studies on a large series of patients and by long periods of adequate observations.<sup>7</sup> In the present study the relapses which occurred following withdrawal of the therapeutic agent or substitution of a placebo served to evaluate the specificity of the extract.

Several procedures described elsewhere<sup>8</sup> were used in the preparation of the extract of intestinal mucosa. It was soon found that only certain extracts were effective and that others contributed no benefits whatsoever. It should be emphasized that the potency of these preparations cannot be determined at present by any of its physical attributes or chemical properties. The only test for potency now available is the effect of the preparation on patients. *Particular caution* is necessary to distinguish between the effects of the therapeutic agent and spontaneous remissions.

We believe that the results of this study still offer only presumptive evidence that non-specific ulcerative colitis is due to a deficiency of an intrinsic factor. Symptomatic improvement and healing of the ulcerated areas occurred in association with treatment with intestinal extracts and did not appear to be spontaneous remissions of the disease.

It is probable that in this study the beneficial effects of intestinal extracts would have been more striking if we had "treated the patients as well as the disease." However, this was not done since such a course would have given us less information about the effectiveness of the intestinal extracts.

At present the exact mechanism of the therapeutic response is unknown. It is hoped

that further study will clarify this problem. The exacerbations which occurred on withdrawal of treatment suggest that sustained improvement may be possible only as long as therapy with the intestinal extract is maintained.

#### SUMMARY

To test the hypothesis that non-specific ulcerative colitis is due to the absence or a deficiency of an intrinsic factor normally present in the intestinal mucosa, oral treatment with extracts of hog's small intestinal mucosa was undertaken in seventy-one patients. A total of twenty-seven of these patients have been followed for one year or longer. Symptomatic and sigmoidoscopic evidences of improvement were shown in twenty-four cases. After remission of symptoms, withdrawal of the intestinal extract or substitution of a placebo resulted in relapse, with remission occurring

again upon resumption of treatment. It is probable that sustained improvement can be maintained only by continued administration of the extract.

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# SURGICAL TREATMENT OF NON-SPECIFIC ULCERATIVE COLITIS

WALTER A. FANSLER, M.D. AND HOWARD M. FRYKMAN, M.D.  
*Minneapolis, Minnesota*

**S**URGERY in idiopathic ulcerative colitis may be indicated in either the acute or chronic type of the disease. Since many patients with ulcerative colitis can be managed successfully by medical treatment, it is important to determine which patient should be subjected to surgery. For practical purposes the disease can be classified into three groups, including the mild type, the moderately severe, continuous or recurring types and the fulminating type.

The mild type with its typical periods of activity and quiescence usually offers little inconvenience to the patient other than the passage of blood and mucus with frequent loose or soft stools. In these cases proctoscopic examination shows merely a red and granular mucosa with no frank ulceration. There are no constitutional symptoms and x-ray studies are frequently negative or may show only slight spasticity. Frequently when these patients are examined during a quiescent period, a normal mucosal pattern will be found with no evidence of ulcerative colitis ever being present. The majority of these patients with mild ulcerative colitis respond well to medical management and surgical intervention is usually not indicated.

The fulminating type of case may develop suddenly in a previously normal individual or it may occur as an overwhelming exacerbation in the mild type or moderately severe group. It is characterized by severe toxicity, highly elevated temperatures and severe, crampy, abdominal pain along with profuse liquid stools consisting almost entirely of blood, pus and mucus. The mortality is very high in this type of disease regardless of what is done, with death resulting from toxemia, perforation and peritonitis or profuse hemorrhage from the colon. Surgery is indicated as an emergency procedure in these cases. The only indication for delay is for the utilization of transfusions and other emergency supportive measures in preparation for surgery. As a general rule the earlier these patients are

operated upon the lower will be the overall mortality. Ileostomy is the present procedure of choice but it is possible that in the future transthoracic vagotomy may supplant it.

The great majority of ulcerative colitis patients are classified in the moderately severe, continuous or recurrent group. This type is usually characterized by remissions and exacerbations although the activity may be continuous with gradual progression of the disease. In over 90 per cent the disease process begins in the rectum and extends in a proximal<sup>9</sup> direction until the entire colon is involved. Chronic ulceration of the mucosa and the infiltration of the bowel wall by the inflammatory process gradually converts the colon into a greatly thickened and markedly shortened fibrotic tube. During exacerbations varying degrees of toxemia are evident due to absorption from the diseased bowel with associated fever, anemia and loss of weight. Severe irreversible changes may occur within the bowel in a relatively short time or remissions lasting months or years may occur. All such cases should be given trials with an adequate medical regimen during the early phases of the disease but surgery is definitely indicated if the patient has frequent disabling recurrences or if the condition appears to show active progression. Surgical procrastination will not only lead to destruction of the colon both anatomically and physiologically but may ultimately lead to the development of such complications as arthritis, stricture formation, anal and rectal fistulas, recurrent thrombophlebitis, perforation, hemorrhage, polyposis and malignancy. Delay until surgical intervention becomes imperative also greatly increases the operative risk.

At the present time there is no yardstick which will definitely indicate when to abandon conservative measures and resort to surgery. This point varies with individual opinion and experience but it is obvious that the more recent trend is toward earlier and more frequent surgical intervention. Operations found



most useful are (1) ileostomy alone; (2) ileostomy with complete colectomy, with or without removal of the rectum; (3) partial or complete colectomy with anastomosis of the ileum to the remaining segment of colon or rectum and (4) vagotomy. Ileostomy alone as a permanent measure is usually not satisfactory except in early cases. The colon is often so badly diseased that even though it is placed at complete rest it continues to remain a source of infection. Troublesome complications may occur or, if already present, they usually persist until the colon is removed. There is also the ever present danger of malignant degeneration in long-standing cases of ulcerative colitis. Statistics as to the frequency of this condition vary from 2 per cent as reported by the Lahey Clinic to 13 per cent as found by Dennis at the University of Minnesota. Therefore, it is better that the colon be removed with or without the rectum. If the colon and/or rectum is left intact, it should be carefully examined at frequent intervals for evidence of polyp formation or early malignancy.

From the patient's point of view a partial removal of the large bowel with anastomosis of the ileum to the remaining pelvic colon is the most acceptable procedure since the continuity of the bowel is not interrupted and the inconvenience of an ileostomy is obviated. This can be readily accomplished in the uncommon, segmental type of ulcerative colitis in which the rectum remains normal. If minimal to moderate rectal changes are present with a more extensive disturbance higher in the colon, there are two possibilities: The first and most generally accepted procedure is to perform an ileostomy and resect the colon as far as the rectum, leaving that organ intact. At a later date if the disease process in the remaining segment subsides, an ileorectal anastomosis may be done. Garlock and Cave have reported several cases in which this procedure was done without subsequent recurrence. However, reactivation of the disease does occur frequently in the rectal stump. The process may be so mild that no further treatment is indicated or the recurrence may be so severe that restoration of the ileostomy and ultimate excision of the rectum may be necessary.

The other possibility is the anastomosis of the ileum to the rectum at the time of the colectomy even though minimal rectal changes are present. In one instance this was done.

Prior to the operation the mucosa was edematous and granular in appearance and bled easily upon swabbing. No distinct ulcerations were present and the rectal distensibility was about normal. In the two years which have elapsed the condition of the rectum has remained unchanged. The patient has several soft stools daily and occasionally passes a small amount of blood. Her general health is good and she prefers her present status to one with a permanent ileostomy. Whether this patient will improve, continue on in her present state or require re-establishment of the ileostomy is a problem for the future. Wangenstein has reported two cases in which colectomy was done with anastomosis of the terminal ileum to the remaining pelvic colon even though proctoscopic examination showed activity of the disease process. In these cases this procedure was followed by complete healing of the rectal stump.

It is our belief that if an ileoproctostomy is done the anastomosis should never be made lower than the upper portion of the rectal ampulla. If the suture line is placed too near the anal canal, stricture formation at the site of the anastomosis and poor bowel control usually occur. Constant soiling by the dribbling of the ileal contents causes the perianal skin to become macerated and painful. If the entire rectum is removed and the ileum brought out through the anal canal, the results are even worse. A permanent ileostomy with a Rutzen bag is far more comfortable and satisfactory.

We use a single barrel or end ileostomy with the proximal ileum being brought out through a separate incision while the distal end is inverted and dropped back into the peritoneal cavity. The mesentery is carefully sutured to the peritoneum of the anterior abdominal wall as insurance against retraction or external prolapse of the ileum. We no longer anchor the ileum to the parietal peritoneum by placing sutures in the wall of the bowel itself since even with the use of the finest needles and suture we have frequently had sinus formation occur.

Until recently surgical treatment of ulcerative colitis has been directed entirely toward the intestinal tract. In October, 1946 Dr. Clarence Dennis at the University of Minnesota performed a transthoracic vagotomy for this condition. In March, 1948 he reported nineteen cases in which he had done a bilateral

vagotomy for the treatment of idiopathic ulcerative colitis and regional enteritis. of this group 73 per cent had either shown definite improvement or had become entirely asymptomatic.

One of us (H. M. F.) has had the opportunity of making proctoscopic observations on a considerable number of the patients in the series of Dr. Dennis and was so impressed that the procedure was recommended to several patients under our care. We had four patients in whom transthoracic vagotomy was done. The first patient in our very small series was operated upon eleven months ago and the latest four months ago. Obviously the time is too short and the series too small to come to any definite conclusions. However, from the observations made on the few patients reported in this paper and from examinations made in conjunction with Dr. Dennis it would seem almost certain that transthoracic vagotomy will have a definite place in the treatment of idiopathic ulcerative colitis in the future.

Our patients had a history of the disease process varying from eight to nineteen years with numerous remissions and exacerbations. In one case there had been a complete remission for almost ten years. Vagotomy was done in each case during a period of acute exacerbation which was not responding to medical management. All showed typical x-ray changes with ulceration of the mucosa, shortening of the colon and loss of haustrations. To date three of these patients have shown marked improvement after years of prolonged illness. All have had weight gains with improvement in their general health. One patient showed a completely healed rectum and distal sigmoid colon three months after surgery. Considerable scarring was evident but the colonic mucosa was otherwise pale and normal throughout. He now has from one to three or four soft stools daily. The remaining two patients still show patchy granular areas but slow improvement in the appearance of the mucosa is apparent at each subsequent examination. All are having soft stools varying from two to five daily with rare traces of blood. Barium enemas at varying intervals postoperatively have shown the mucosal pattern to be improving but no change has occurred in the irreversible constriction of the colon. These three patients are now gainfully employed at their previous occupations.

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The patient who made the least improvement was a forty-seven year old, white female with a seventeen-year history of ulcerative colitis. At the time we first observed her she had severe exacerbation of the disease with eight to ten stools daily. Barium enema showed extensive involvement of the entire colon with marked shortening and complete loss of haustrations plus questionable involvement of the terminal ileum. A transthoracic vagotomy was done seven months ago. During the first five months postoperatively she showed no subjective improvement and at times was definitely worse with often twelve to fifteen stools daily. However, her condition has improved in the past two months, with a 10 pound gain in weight and a decrease in the number of daily bowel movements. She remains a chronic invalid and still passes three to eight stools daily containing small amounts of blood and pus. Proctoscopic examination now shows some improvement; but unless there is further favorable change in the appearance of the bowel and in the general condition of the patient, this result must be considered unsatisfactory. Ileostomy and, ultimately, total colectomy may be necessary to restore this patient to a state of comparative health.

Another patient, nineteen years old, who was seen in consultation and already reported in Dennis' series, had an acute fulminating type of the disease having been in good health until about four weeks prior to the examination. He appeared acutely ill with all the signs and symptoms of acute sepsis. He had been having severe abdominal cramps and profuse diarrhea since the onset of his illness and had lost approximately 50 pounds. Barium studies of the intestinal tract showed that the ulcerative process involved not only the colon but also the ileum and jejunum as well. A transthoracic vagotomy in this patient was followed by immediate clinical improvement; and when the patient was seen again three months later, he had gained 30 pounds in weight and had returned to school. He had no complaints of any kind and was passing one formed stool daily.

#### SUMMARY AND CONCLUSIONS

From our observations it is evident that properly selected patients with idiopathic ulcerative colitis will show improvement or apparent cure following transthoracic vago-

tomy. The most striking results have been in the acute fulminating type of the disease and it is in this group that the highest operative mortality has been previously encountered with the use of emergency ileostomy. In our series the procedure has been used in four patients with chronic ulcerative colitis, with varying results. One patient appears to be cured, two show marked improvement and the fourth shows moderate improvement. Considerable time must elapse before it can be determined whether complete resolution of the chronic inflammatory process will occur or whether these results will be permanent. In general the procedure seems more applicable in the acute and early chronic types of the disease before irreparable damage to the colon has occurred. In the intractable cases in which the colon has been converted into a thickened, fibrotic tube lined chiefly with infected granulation tissue and in those showing evidence of polyp formation, the methods of intestinal surgery as outlined in this presentation are the procedures of choice.

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DISCUSSION OF PAPERS BY DRs. HASKELL AND FRIEDMAN AND DRs. FANSLER AND FRYKMAN

M. H. F. FRIEDMAN (Philadelphia, Pa.): First I should like to add a few remarks to our paper

presented by Dr. Haskell. You may have noticed the development of costiveness upon continued treatment with intestinal extract. This has been experienced by about seven patients. The reason for this we do not know. It may be due to overdosage. It may be due to increased reabsorption of water, either as the direct result of the extract or consequent to the decrease in number and frequency of stools. Nearly all the patients have shown remarkable weight gains. We have also treated three patients with ileitis, with very favorable results. Each of the three has had some part of the ileum resected previously but unsuccessfully. Now they appear to be symptom-free while continuing with intestinal extract.

I am not a surgeon; I should therefore like to limit my remarks to some of the physiologic aspects of vagus nerve resection, particularly as they pertain to the interesting and cautious paper by Drs. Fansler and Frykman.

Recently the old procedure of vagotomy has been revived by Dragstedt and others for the surgical treatment of peptic ulcer. According to a survey made this year by the American Gastroenterological Association, since then approximately 9,000 patients with peptic ulcer have been subjected to bilateral vagus section for treatment of peptic ulcer.

Following vagotomy, gastric retention appears to be the immediate untoward effect of greatest importance. In man a barium meal may stay in the patient's stomach after vagus section for as long as five days. In our vagotomized dogs with a cannulated gastric fistula the opening of the fistula results in the release of an overpowering stench. The gastric contents have been stagnant and putrifying for days. In rats that we have vagotomized the stomach may become so dilated in two or three days as to be at least five times the normal size.

The gastric retention may be corrected by giving parasympathomimetic drugs like mecholyl or urocholine to hasten gastric evacuation. Nowadays most surgeons will not do vagotomy alone without combining it with some operation, such as gastroenterostomy or partial gastric resection, to offset the gastric retention. I would be very much interested to learn whether the patients that had been vagotomized for ulcerative colitis also show this marked delay in gastric evacuation.

The effects of vagotomy on the pancreas and gallbladder are noticeable although not marked. Pancreatic secretion in response to food has been found by Pincus and Thomas to be reduced by about 60 per cent. Snapc, in our laboratory, has found that vagotomy also delays emptying of the gallbladder in response to food but does not abolish it entirely.

The observations made in Pavlov's laboratory have been most interesting. The Russian investi-

gators noted that one of the commonest results of complete vagotomy was the marked vulnerability of the bowel. Substances usually only mildly irritating to the intestinal mucosa would precipitate profuse hemorrhage and cause death if given after vagotomy.

In vagotomized dogs with intestinal fistulas we have seen repeatedly that light swabbing of the duodenal or jejunal mucosa results in profuse bleeding. Frequently we have seen bleeding even without any irritating stimulus. In dogs with experimental peptic ulcer Saltzstein reported that complete vagotomy resulted in jejunitis and ileitis in over 60 per cent of the experimental animals.

In our dogs bouts of diarrhea have been observed frequently. In peptic ulcer patients development of diarrhea has been a common after effect of vagotomy. These observations I find most interesting and pertinent in view of the vagotomy operation for relief of a disease giving these very symptoms.

In a recent paper Thomas and Komarov came to the conclusion that a truly complete removal of the vagus nerves is probably a rare occurrence and perhaps fortunately so. They believe that 100 per cent vagotomy is never beneficial but always detrimental to the organism, either man or animal. Evidence of regeneration of the vagus nerves has been obtained by many workers; however, these regenerated nerves are anatomic structures and no one has yet shown them to be functional. This is an interesting subject for future study.

If I may, I should like to make one more comment and one suggestion. We know from numerous studies that complete denervation of a visceral structure sensitizes that organ to the chemical substances that mediate the nerve impulse. Thus, sympathetic denervation of the heart makes it extremely sensitive to traces of adrenalin. This was described by Cannon and is usually referred to as the law of sensitization by denervation. The question I raise is this: Is complete vagotomy of the intestine desirable? Would not the operation sensitize the intestine to bring about the very parasympathetic effects that you think should be abolished? I should like to suggest this: Why not crush the vagus trunks or inject them with alcohol? The effects would not be permanent but probably endure long enough to bring about the bowel rest you seek and so perhaps interrupt a vicious cycle.

May I take this opportunity of digressing to see if I can obtain confirmation from you who have the experience of some observations which we have made? It is our impression that ileostomy with the colon in place results in discharge of liquid stools, so much so that the ileal stoma may become very bothersome. However, formed stools frequently occur from the ileal stoma if the colon has been removed. That has been our impression and I should like to have confirmation.

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Finally, I should like to thank Dr. Fansler very much for his interesting paper. I think he will agree that this operation of vagotomy for ulcerative colitis is still, and should so be regarded for some time to come, an experimental procedure.

CLARENCE DENNIS (Minneapolis, Minn.): With regard to Dr. Fansler's comments concerning fecal fistulas complicating ileostomies, it has been my experience that this complication has not occurred in over sixty ileostomies. I believe that the reason for this is probably placement of the sutures in the wall of the bowel. They should be placed no deeper than the submucosa.

A review of the cases of idiopathic ulcerative colitis treated conservatively at the University of Minnesota Hospitals in the ten years ending January 1, 1944, showed a high hospital death rate (28 per cent). It is true that those transferred to a surgical program only after reaching a moribund state were classed as non-surgical cases. Those patients given surgical therapy in this period under elective indications or without drastic emergency numbered twenty-five and suffered an 8 per cent hospital mortality.

Studies of those treated conservatively and who survived showed more than one-half to be worse after dismissal than before admission. Of those dying under conservative therapy only two of sixteen died of causes not related to ulcerative colitis. Those survivors of non-surgical therapy who could be followed ten years after dismissal showed a mortality rate at the dismissal of more than 50 per cent.

As a result of this experience indications for surgical intervention were revised. All those with fulminating, all moderately severe and most mild cases of ulcerative colitis have since been considered candidates for surgical intervention. Since that time, I personally have seen fewer than five patients in whom surgery was not advised. It has been refused in only three cases; one of these patients is dead.

In the past two years our plan of surgical attack has been changed by the adoption of vagotomy in the therapy of this disease. The employment of division of the vagus nerves for colitis was imposed upon us in October, 1946 by a patient who developed active ulcerative enteritis in the 6 feet of jejunum and ileum which remained after numerous resections of colon and ileum for ulcerative colitis and enteritis. The response was striking and led us to employ vagotomy as the sole surgical procedure in four patients with low grade colitis. They were observed for six months, at which time all four were asymptomatic and all four showed a healed mucosa on proctoscopic examination.

Since this finding, all patients coming to the University of Minnesota Hospitals and the Minneapolis General Hospital as candidates for surgery for idiopathic ulcerative colitis have been

subjected to vagotomy. Twenty-eight such procedures have been undertaken for colitis or enteritis and one for functional diarrhea of four years' duration.

Of the twenty-eight patients three are dead. One suffered cardiac arrest during surgical approach. One died ten weeks after vagotomy performed for a severe flare-up occurring six months after an ineffective ileostomy which had been done under desperate circumstances; she was found at autopsy to have multiple fistulas from the ileum to the sigmoid colon, thought to antedate the ileostomy. The third died several months after vagotomy from intestinal obstruction treated elsewhere; he had achieved improvement in his ulcerative proctitis. Our most striking case has already been related by Dr. Fansler.

Twenty-five patients with colitis have been followed two months or more and are thus available for evaluation. Sixteen have had vagotomy as the sole surgical procedure. Six of them are asymptomatic and four are improved. Five are listed as unimproved; one of them was seen by me and he should be listed as improved now. One patient is worse having suffered a severe flare-up three months later following a barium enema; emergency ileostomy was required.

Seven patients had ileostomies prior to vagotomy. Six of them are asymptomatic or improved. Twenty of our cases were universal in type and one-half of these presented ileac involvement, a point which did not seem to affect the outcome. Five were regional; three of the excellent results had a classical regional enteritis separated by normal ileum from the colon.

Roentgen evidence of improvement in the colon after vagotomy is the rule, but there has been only one case in which the appearance has entirely returned to normal. This patient is one of three who suffered an exacerbation after many months of improvement subsequent to vagotomy. The proctoscopic appearances have shown definite improvement within two weeks in a majority of the twenty patients still retaining rectums. Four patients with active disease have reverted to a normal appearance.

Certain studies have been prosecuted in an effort to gain an understanding of the mechanism of the effects observed. With our observation of striking improvement in the first cases, Lillehei, Dixon, Friesen and Wangenstein directed the experiments they had already been performing on the origin of colitis toward the possible rôle of autonomic innervation. They found, as Lium had, that prevertebral sympathetic ganglionectomy produces a usually fatal, purulent, bloody diarrhea in dogs. This effect does not follow if vagotomy is done at the same sitting.

That transit time of material through the stomach is prolonged after vagotomy is common knowledge. In each case an effort was made to

determine the precise time of entry of barium into the duodenum and of exit from the terminal ileum. In eight cases it was possible to gather these data both before and after vagotomy. The mean pre-operative transit time was three and one-half hours, that postoperatively was seven and one-half hours. In no instance did the passage fail to be slower after surgery.

Motility studies on the ileum were also employed using a long tube and a balloon and tambour. There seems to be a definite lessening of motor activity after vagotomy, but our data are still incomplete. Barium transit time through the colon was tripled after vagotomy, but determinations were difficult to establish precisely and were adequate in only three cases.

Wolf and Andrus have shown that the mucous membrane of the stomach becomes engorged on violent emotional reaction and that this reaction is blocked by division of the vagus nerves. In discussions with Dr. Cranston Holman of the Cornell Medical group the idea arose that this same change might be visible in the mucous membrane of the rectum. To determine this three patients were examined in the Sims position over a period of twenty minutes while discussions were carried on which were known to be emotionally disturbing to the patient. Violent emotional reaction resulted in two of the three patients in marked engorgement and in one, at least, superficial petechial hemorrhages developed under observation. In the third patient we could not find a subject which was disturbing. After vagotomy these changes did not occur. This evidence is, of course, too scanty for drawing definite conclusions, but it does suggest that the vagus perhaps indirectly has something to do with the mucosa of the rectum.

In answer to Dr. Friedman we have seen serious gastric retention only once; this patient required a gastro-enterostomy. Two other patients have had some postoperative gastric retention but this disappeared in a few weeks. Development of diarrhea after vagotomy has not been seen in our group nor has it been seen in about twenty-five patients in whom vagotomy has been done for duodenal ulcer. Finally, Dr. Friedman mentioned that he had seen the ileac discharge become more solid after removal of the colon in patients with ileostomies. We have not seen this occur in any instance.

In conclusion, the following statements should be emphasized: We have been unable to select those patients who will respond satisfactorily to vagotomy as failures and brilliant results have been seen in both early and late cases. It seems, upon reviewing our data, that marked rigidity portends a poor result; at least in this group a period of many months can be expected to pass before benefit will be seen. This is perhaps fortuitous for the cases of many years' standing are those in

which a cancer rate of approximately 14 per cent has been found.

Finally, it must be emphasized in particular that we are in no position to recommend that this type of therapy be generally adopted. It seems proper that vagotomy should not be done for ulcerative colitis unless it is done under well controlled circumstances in which the patient will be carefully studied and carefully followed. In other words, it should not be done except in an effort to evaluate the procedure. There is no basis as yet for recommending this procedure without qualification in ulcerative colitis.

THOMAS T. MACKIE (Winston Salem, N. C.): I am hesitant about my discussion partly because I am an internist and not a surgeon, partly because I have no experience whatever with the intestinal extract and partly because my experience with vagotomy has been limited to one unfortunate result, but one which to me is extremely illuminating.

I have a strong belief that many of the presentations dealing with the medical and surgical care of this disease appear to be at cross purposes because there is lack of a uniform basis for discussion. We must recognize that idiopathic ulcerative colitis is a cyclic and recurrent disease. We must recognize that the cycles of the disease, with regard to their duration, vary as between one patient and another and, further and even more unfortunately for purposes of clinical evaluation, they will vary decidedly with the same patient if one follows that individual as I have had the opportunity to do with many over considerable periods of years.

A further difficulty lies in the fact that we have no means of determining whether a particular therapeutic procedure is in effect responsible for the improvement that may occur; in other words, we cannot identify the spontaneous remissions which we know occur in the great majority of these cases.

It seems to me, therefore, that in any consideration of a new form of therapy we must have or attempt to have certain fundamental controls. Most important among these are evaluation of the factors which play primary or secondary rôles in the etiologic mechanism. This immediately raises the question as to what constitutes effective medical care. This question is particularly pertinent this morning because whenever we hear a presentation of the rôle of surgery in the treatment of this disease it is postulated by the surgeon that the patient has previously been subjected to competent medical investigation. Frequently, this is not the case. Competent study implies evaluation in the individual case, often over a prolonged period of time, of potentially important factors such as the rôle of primary and secondary infection, sensitization to foreign proteins and secondary disturbances of physiology. Evaluation of the physiologic changes that occur in the gastrointestinal tract are essential especially in severe cases. Hypochlor-

hydria or achlorhydria are not unusual and when present contribute to the severity of the disease. Disturbance of the motor physiology of the colon likewise is common producing what we have called a "constipated diarrhea." This is characterized by prolonged retention in the right half of the colon, frequent small evacuations commonly consisting principally of blood, mucus and pus and by increasingly severe spasm of the distal half of the colon. Subjective and objective improvement are promptly obtained by the judicious use of saline catharsis.

A further complicating factor is the frequent occurrence of sensitization of the colon to foreign protein of food and bacterial origin. Failure to recognize and to control this element in the mechanism may nullify any therapeutic approach and profoundly affect the prognosis.

Finally the numbers of cases presented, the conditions of the particular investigation and the duration of the periods of observation frequently are such as to render impossible statistical analysis of the observations and determination that the effects observed are not in fact the result of chance.

Dr. Haskell's paper presents an extraordinarily interesting hypothesis which could explain many of the puzzling features of the disease. The evidence at present, however, does not permit evaluation of the possibility that an intrinsic deficiency may be a factor in the pathogenesis. There are certain dubious features. An active principle in the intestinal extract has not been demonstrated. There is no method of assay other than the uncontrolled one of clinical trial. Finally the limited number of cases and the short follow-up period make it impossible to be entirely certain what the ultimate outcome will be in the treated individuals.

There are certain suggestive features. The apparent recurrence of symptoms and objective signs following withdrawal of the intestinal extract and the sequence of events observed in the healing process are those which I believe one would anticipate finding if a specific therapeutic agent were proving to be effective.

I should like to ask certain questions. Were consecutive or alternate cases used for evaluation of the intestinal extract? Were the cases grouped in terms of relatively comparable pathology? Were the patients receiving the extract aware of the fact that a new therapeutic agent was being used?

Dr. Fansler has given a most interesting presentation of experience with vagotomy. I am unconvinced about the ultimate value of this procedure with the possible exception of the acute fulminating cases which so frequently progress to an early fatal termination. The immediate and marked improvement occurring in the one acute case reported is perhaps an important observation because these are the cases frequently subjected



to ileostomy in the past and subject to a high mortality rate.

The rationale of vagotomy in ulcerative colitis is based upon control of motility and spasm of the colon. However, I have been unable to find anatomic or physiologic evidence to justify the assumption that section of the vagi will accomplish this end. In the only case which I have had the opportunity of following clinically vagotomy appeared to have little or no effect upon the spasm, and radiologically there was no demonstrable difference in the motility of the colon. Assuming, however, that motility and spasm may be reduced by vagotomy, the resulting disturbance of normal motor function might well create a physiologic change which we have found to occur as a definite complication of the disease. Dr. Dennis and the group in Minneapolis have encountered a surprisingly low incidence of gastric dilatation. This has not been the experience in other parts of the country and again I should fear the occurrence of this complication in the seriously ill patient.

The one case of vagotomy in ulcerative colitis that I have had the opportunity to follow illustrates the need for caution in resorting to this procedure and likewise the hazard of interpretation of results based upon a brief follow-up period. The patient, a young married woman with a severe form of the disease, had been in the hospital for something over a year. During this period she exhibited many of the devastating complications, including marked deficiency disease, pyoderma, multiple perianal fistulas and rectovaginal fistula. The history was suggestive of a probable food allergy. This could not be substantiated, however, by clinical study. Medical management did not yield satisfactory response and I considered her a suitable case of ileostomy followed by subtotal resection of the colon. However, it was decided to try vagotomy. Some three weeks later she was presented at a staff conference having improved to such a degree and having gained so much weight that I did not recognize her. Shortly thereafter she was discharged. Seven weeks ago she returned to the hospital in a very acute exacerbation after approximately five months of remission. The onset was acute occurring within thirty-six hours after taking a considerable amount of chocolate candy. During the previous admission we had suspected from the history a definite allergy to chocolate but had not been able to prove it conclusively. The subsequent course was progressively downhill ultimately terminating in fatality.

In this instance vagotomy was followed by a marked remission but conferred no protection against early and fatal relapse. The case further illustrates the fallacy of resort to palliative rather than definitive surgery before the individual pathogenic factors have been fully evaluated. This and many other experiences with the medical and

surgical therapy of ulcerative colitis have forced me to certain definite conclusions. I am convinced that the surgeon and the internist interested in intestinal diseases could make important contributions to our philosophy of the management of this condition if, by some means, we could arrive at a standardized joint method of investigation and management prior to resorting to surgery.

I am in full accord with the concept that there are two groups of patients who should have immediate and radical surgery. They comprise those with the proximal type of the disease in whom the distal colon is uninvolved and those with the long-standing chronic type with a fibrotic colon wall, especially if pseudopolypoid degeneration is present.

I should like particularly to emphasize one of the fundamental problems of treatment. Surgical intervention, irrespective of the type of procedure, done in advance of completion of competent medical study permanently ties the hands of the internist. It becomes impossible to evaluate factors such as a possible allergy and in the case of palliative surgery, such as ileostomy followed by ileosigmoidostomy, it exposes the patient to the hazard of early postoperative acute relapse.

I am unwilling as yet to accept vagotomy as a suitable therapeutic procedure for ulcerative colitis, with the possible exception of the extremely acute fulminating case. I most heartily second Dr. Friedman's inquiry: why not profit by the long experience in the surgical treatment of pulmonary tuberculosis by phrenic crush? Why not attempt vagal crush rather than vagal section? This procedure would yield the same immediate physiologic changes and not leave us a patient with an irrevocable physiologic defect which of itself may be a serious hazard and at the best is still of uncertain permanent benefit. Apart from the questionable effect on the primary disease I question whether we yet know the ultimate effects of extirpation of the vagi.

GARNET W. GAULT (Washington, D. C.): Those of us who are especially interested in chronic ulcerative colitis are aware of the bizarre nature of this disease. Time does not permit a full discussion of the various factors that enter into the etiology of ulcerative colitis. Dr. Haskell has based the rationale for the use of extract of hog small intestinal mucosa on the premise that one of the etiologic agents is a deficiency of an intrinsic protective element which is normally present in the mucosa of the colon. This intrinsic protective element is supposed to inhibit self-digestion by proteolytic enzymatic activity. If the thesis is correct that there is a deficiency or an exhaustion of an antiproteolytic enzymatic element in the colon in cases of ulcerative colitis, then this work demonstrates that adequate dosage of extract of hog small intestinal mucosa supplies that anti-

proteolytic enzymatic element. I am sure we all wish that this assumption is the correct and complete answer to the problem at hand.

However, I would like to call your attention to other work vitally related to this problem. Documentary evidence is available that proteolytic enzymes are present in excess of normal in diarrheic stools. Tissue autolysis once started in an acid pH favoring proteolytic action can continue regardless of the pH variation in the tissues. There is evidence that the intestinal mucosa can be autolyzed by exogenous proteolytic enzymes elaborated by living putrefactive bacteria. It is, therefore, entirely probable that proteolytic enzymes, pH of the intestinal contents and mucosa itself and bacterial content of the colon are all interrelated.

Dr. Haskell has not had time to mention briefly that gastrointestinal hypermotility is to be considered in relation to the entire problem. If we concede that gastrointestinal hypermotility allows proteolytic enzymes to be more abundant and active in the colon than under normal conditions, then an additional element enters into the picture. Time does not permit a discussion of the reports of Mann, Kawamura, Cannon, Starling, Lium, Dragstedt and many others which indicate that intestinal hypermotility has something to do with this disease. Investigation of the neurogenic factors in relation to ulcerative colitis is being carried on and reported.

If Dr. Haskell and his associates have succeeded in counteracting this mucosal dissolution by substitution therapy in the form of extract of hog small intestinal mucosa, they have made an outstanding contribution to the treatment of chronic ulcerative colitis. Their discussion and tables indicate that extract of hog small intestinal mucosa should be of the greatest value in patients with early cases of ulcerative colitis who have not developed structural changes in the colon. It is to be noted in Table 1 of Dr. Haskell's paper that nineteen of twenty-three patients had this disease three years or less. The fact that in sixteen of twenty-three patients the disease was limited to the left colon and/or rectum is not inconsistent with the general location of the disease process. It is unfortunate that Dr. Haskell could not discuss several of these cases in detail. This study indicates that continued treatment without rest periods is to be carried out and that symptomatic improvement occurs before roentgen or proctoscopic evidence of improvement is available. I am reasonably sure that they did not expect to influence materially the status of the polypoid degeneration seen in two cases. If they can prevent dissolution of the mucosa which is the effective barrier against secondary infection by a variety of bowel organisms, they have accomplished a great deal.

On behalf of my surgical colleagues who wish that the problem of ulcerative colitis would always

remain medical, I congratulate Dr. Haskell and his associates on their preliminary investigative report. I hope they will report the further results of this work before all of us a few years hence. If they can arrest the extreme colonic damage, prevent the development of surgical complications and rehabilitate these seriously ill patients, they have our deepest gratitude.

It is always a special pleasure to enter into a discussion of the surgical treatment of ulcerative colitis for one is frequently on controversial ground and a stimulating discussion can be anticipated. I find myself in agreement with Dr. Fansler in many respects but in dissecting his paper I must confess that some of the contents are not too clear. I am sure this is an oversight but they do merit discussion.

It is difficult to accept the statement, "In these cases, proctoscopic examination shows merely a red granular mucosa with no frank ulceration." Is it not true that a granular mucosa represents a phase in ulcerative colitis where a diffuse ulceration of the mucosa occurs so that little or no intact mucosal surface is seen due to diffuse 1 to 2 mm. ulcers. I assume that Dr. Fansler means that there are no large ulcers forming an irregular geographical pattern of mucosal denudation.

It is acknowledged by all concerned that the treatment of acute fulminating ulcerative colitis is indeed difficult. For the present I do not find myself in accord with the heroic views of those who advocate ileostomy for this phase of the disease. To date I am not aware of any published figures comparing the mortality rate and results in patients who have had ileostomy for acute fulminating ulcerative colitis and those who have had ileostomy for continuous and recurring chronic ulcerative colitis with disability or complications. Most of the surgeons and proctologists who have discussed or utilized ileostomy for acute fulminating ulcerative colitis have indicated that a prohibitive mortality varying from 25 to 50 per cent is to be anticipated. If this is correct, then the statement "as a general rule, the earlier these patients are operated upon the lower will be the overall mortality" will require factual support omitted in this paper. Furthermore, this quotation is inconsistent with "The most striking results have been in the acute fulminating type of the disease, and it is in this group that the highest operative mortality has been previously encountered." It is not difficult to understand the attitude of our medical colleagues who view ileostomy with disfavor under these circumstances. It is a pleasure to note that Dr. Fansler is hopeful that vagotomy will supplant ileostomy in this type of case.

Dr. Fansler has indicated that chronic recurrent or continuous ulcerative colitis with disability complications and a probable irreversible structural change in the colon may become surgical. The surgical treatment of ulcerative colitis is now on



safer, less controversial ground. It is true that the timing is most important for one does not want to wait, in the face of active progression or disabling recurrence, until one has a poor candidate for surgical rehabilitation. We have been satisfied with the following indications for surgery in this group: (1) chronic ulcerative colitis with constitutional and visceral degenerative changes; (2) anorectal complications; (3) polypoid degeneration and carcinoma; (4) obstruction and tumor mass; (5) perforation abscess and fistula; (6) segmental ulcerative colitis. Questionable indications for surgery have been considered as (1) hemorrhage; (2) acute fulminating ulcerative colitis; (3) acute perforation.

Dr. Fansler mentioned that anastomosis of the ileum to the diseased rectum had been done in one patient and that Dr. Wangenstein reported two similar cases. The rectum subsequently healed in two patients and remained unchanged in one patient. Inasmuch as this is not a common practice I hope he will discuss the rationale of this further for it is indeed a departure from accepted surgery. I am sure we are extremely interested in the reasons for doing this and the anticipated outcome over a long period of time.

There are many of us who are following the work of Dennis with interest. He has reported his results with vagotomy performed on twenty-three patients with ulcerative colitis, some of whom had regional enteritis. We are indebted to Dr. Fansler for bringing this to our attention again. This work represents an original effort to determine what type of patient will derive the most benefit from vagotomy. Preliminary reports indicate that those with early cases of chronic ulcerative colitis and the acute fulminating cases of ulcerative colitis will

derive the most benefit from this procedure. I hope Dr. Fansler will continue to participate in this project and that vagotomy will be found useful for some phase of this disease.

BENJAMIN HASKELL (closing): We are at present working upon an animal assay method which I think promises a satisfactory method of determining the presence of an active principle. When the extracts were first used, we suspected that a lysozyme inhibitor was present, but subsequently we found no such inhibiting principle in the intestinal extract; as a matter of fact, some of the preparations have shown a small amount of lysozyme.

In answer to Dr. Mackie, these have been consecutive cases and no attempt has been made—at least I made no attempt—to group them into comparable types as far as pathology was concerned. We treated each patient as he came along and our results were not tabulated according to the type of case.

We were very much aware of the fact that the institution of some new form of therapy might have a beneficial psychic effect and for this reason made careful attempts to avoid having the patient know he was receiving some new form of therapy. He was aware of being given medication but did not know it was something new or experimental. I do not believe that many discussed the type of drug among themselves.

Proteolytic enzymes were studied in a good many of these cases and we did not find an excessive amount of such enzymes present; as a matter of fact, we do not know how the intestinal extract works. Perhaps, as Dr. Gault has mentioned, we hope at some future meeting we may be able to tell you more.



# POLYPOID LESIONS OF THE COLON AND RECTUM\*

ROBERT A. SCARBOROUGH, M.D. AND RUSSELL R. KLEIN, M.D.  
*San Francisco, California*

THE relationship of benign polyps of the colon and rectum to the development of carcinoma has been well established. Three important questions arise upon discovery of any polypoid lesion: (1) Is this a single lesion or is it a manifestation of a pathologic process which may also involve some other portion of the colon? (2) Is the lesion benign, premalignant or malignant? (3) What is the proper treatment?

The purpose of this paper is to present a discussion of these problems, based upon a review of our experience in a series of 458 patients in whom the original clinical investigation revealed presumably benign polypoid disease. This number represents an incidence of 4.6 per cent in 10,000 patients reviewed. Not included are the 531 patients who were treated for clinically evident carcinoma.

The following histologic types of polypoid lesions encountered, comprising only 5 per cent of cases, have been classified as not premalignant:

*Fibroma.* Two instances were encountered. In each case a single polyp of the rectum was present, one sessile, the other pedunculated, with normal appearing covering mucosa.

*Myoma.* There were three pedunculated polyps of this type, with normal overlying mucosa.

*Endometrioma.* Polypoid protrusion into the lumen of the rectum or sigmoid can occur in endometriosis and did so in two cases in this series.

*Hemangioma.* In one child twelve years of age roentgen-ray examination by barium and air contrast enema demonstrated a definite diffuse polyposis of the colon. Proctoscopic examination had revealed a single, dark red, sessile polyp. Laparotomy disclosed innumerable polypoid protrusions into the lumen of the bowel caused by multiple discreet hemangiomas. The entire small intestine was thickly studded with similar lesions.

*Granuloma.* Localized polypoid granulomatous lesions, from 3 to 8 cm. in diameter,

covered with reddened, superficially eroded mucosa, occurred in seven patients. Four were amebic granulomas of the rectum; there was one tuberculous granuloma of the rectum. Two foreign body granulomas were encountered, one in the cecum overlying a heavy cotton ligature on an inverted appendical stump, the other in the rectosigmoid at the site of a tear and subsequent repair incident to a gynecologic operation.

*Lymphoid Polyps.* These may occur singly or as innumerable firm, sessile elevations of the mucosa as the result of submucosal lymph follicle hyperplasia, probably secondary to infection. In our experience this condition appears to bear no relationship to the development of malignancy. This is contrary to the belief that such aggregations of lymphoid tissue may create changes in the overlying epithelium, with eventual formation of adenomatous polyps and ultimate malignant degeneration. In rare instances polyposis of the colon may be due to such lymphoid polyps. This may have been true in the very few reported cases of cure by roentgen-ray therapy.

*Lymphoma.* (Giant follicle lymphoid tumor.) Six examples of this type of tumor have been encountered. In each instance a single lesion in the rectal ampulla was palpable as a firm, smoothly rounded, partially pedunculated tumor 2 to 3 cm. in diameter. The covering mucosa appeared reddened and tense. Microscopic examination showed multiple lobules of extraordinarily hyperplastic lymphoid tissue, with very large, distinct follicles and huge secondary centers with numerous mitoses. In all cases local excision has been followed by no evidence of recurrence.

The following types, comprising 95 per cent of cases, have been classified as premalignant:

*Inflammatory Hyperplasia.* This type of polyp is typically exemplified in the so-called pseudopolyposis which occurs in chronic ulcerative colitis. Such polyps may be found in patients who show no evidence of active ulcerative disease, but the irregularity of con-

\* From the Department of Surgery, Stanford University Medical School.

tour and the reddened covering mucosa is usually suggestive of this type of lesion. Microscopic examination shows a marked hyperplasia of the mucosa, with frequent variation in the staining characteristics of the cells and an associated submucosal inflammation. Malignant degeneration is sufficiently common to warrant classification as a definite precancerous lesion.

*Hyperplasia.* These lesions are usually seen as multiple, pale, flattened elevations a few mm. in diameter in elderly people. Vernon David has compared these to hyperplasia occurring on a senile basis in other parts of the body such as the skin. They are frequently found within a few cm. of a carcinoma. Whether the carcinoma arose in such a lesion or whether they are the result of reaction to infection and irritation secondary to carcinoma is not at all certain. Such lesions, however, have occurred in this series in individuals who had no carcinoma present. Microscopic examination shows a simple hyperplasia, with enlarged glandular structures, normal staining properties of the epithelium and complete absence of any submucosal inflammation.

*Adenoma.* This is by far the most common type of polypoid lesion in all age groups. In size adenomas may vary from tiny sessile lesions to large pedunculated tumors several cm. in diameter. In color they may be similar to the adjacent normal mucosa or may range from light pink to deep red. Ulceration may or may not be present. Single, several or hundreds of such polyps may occur. The microscopic appearance varies from simple adenomatous hyperplasia to more and more irregular structural formation, with variation in the staining properties of the cells and variable frequency of mitotic figures. The microscopic appearance changes almost insensibly to that of a definite malignant tumor. Recognition of actual malignancy is of the utmost importance in determination of proper treatment and is dependent upon examination by a competent surgical pathologist. Some pathologists diagnose any adenomatous polyp as adenocarcinoma grade 1. Some diagnose malignancy on the basis of variation in the staining properties of the cells, ballooning of the crypts or frequency of mitotic figures. Such diagnoses may lead to unnecessary radical operations or a false sense of security in the safety of local excision. The basic evidence of malignancy is invasion

through the basement membrane or muscularis mucosa. When this has been demonstrated, the lesion should be called carcinoma and be treated as such. In the absence of any microscopic evidence of invasion complete local excision or destruction of the tumor is adequate and satisfactory treatment.

*Papillary Adenoma.* This is a distinctive type of adenomatous polyp, commonly considered a rare and relatively innocuous tumor susceptible to low grade malignant degeneration. Our experience does not support this concept. In this series there were sixty patients with papillary adenomatous lesions. Although many of these were benign, others were the site of origin of carcinoma which invaded adjacent organs and metastasized by lymphatic and vascular channels.

These distinctive tumors are extremely soft and spongy, being comprised of innumerable confluent, pliable, papillary stalks. They are rarely pedunculated, usually having a broad based attachment to the mucous membrane. Their diameter varies from a few mm. to many cm., sometimes with involvement of the entire circumference of the bowel for a considerable distance.

Microscopic examination reveals a connective tissue stroma which branches and rebranches. The covering epithelium is composed of columnar cells in single or multiple layers with many goblet cells. Variable hyperchromatism and frequent mitoses are common but are not pathognomonic of malignancy. Irregularity in gland differentiation or ballooning at the depths of the crypts is highly suggestive of malignancy but not diagnostic in itself. The basic microscopic evidence of malignancy is invasion through the basement membrane or muscularis mucosa.

Determination of the presence of malignancy in a papillary adenoma is often difficult. Such degeneration quite characteristically begins deep in the base of the lesion with no surface evidence of malignancy either by palpation, visual inspection or superficial biopsy examination.

Malignant degeneration was found in eighteen of sixty patients, or 30 per cent. In only eight of the eighteen was it possible to demonstrate this by multiple biopsies. In the other ten patients the presence of malignancy was determined in four instances only after complete local removal of the tumor and subsequent

pathologic examination. In six patients a presumptive diagnosis of malignancy was made solely upon the basis of palpation of areas of induration within an otherwise soft, spongy tumor. These six patients were subjected to radical resection and in every instance the presence of definite invasive carcinoma was confirmed by microscopic examination.

Two of the eighteen carcinomas were found inoperable at laparotomy because of liver metastases and direct invasion of the tumor into adjacent organs. Fourteen patients were treated by radical resection. In two instances regional lymph node metastases had already occurred. Three patients, without evidence of glandular metastases, subsequently developed distal metastases to the liver, lung and spine.

We believe that every presumably benign papillary adenoma should be completely excised or removed by diathermy snare, and all of the tumor should be carefully studied by a competent pathologist for evidence of malignant degeneration. If this is present, radical resection is indicated.

#### STATISTICAL DATA IN 458 PATIENTS

In this series the incidence of polyps in males was 10 per cent greater than in females. The age of the patients ranged from five days to ninety-four years. The incidence by decades is shown in Table 1. The infrequency of diagnosis of polypoid disease in the second decade of life is striking. This would suggest that perhaps there is a hormonal factor of embryonic life that is responsible for the relative frequency of polyps in the very young, and that the increasing incidence of polypoid disease in later decades is due to some stimulus, physical, chemical or inflammatory, originating in the individual. There is also undoubtedly a factor of hereditary predisposition as exemplified in familial diffuse polyposis. However, in the majority of cases of polypoid disease we have not been impressed by the importance of hereditary predisposition.

In this series 64 per cent of the patients were found to have a single polyp; 31 per cent had from two to ten polyps and 5 per cent had diffuse polyposis of the colon.

The diagnosis of a single polyp has been accepted only after thorough investigation by barium and air contrast enema examination following proctoscopy. In every patient in

whom any adenomatous polyp is found by proctoscopy, regardless of symptoms, careful roentgen-ray examination is carried out in search of other polypoid lesions higher in the colon. A considerable number of patients in whom a benign polyp was found by proc-

Decade	Per Cent
1.....	10
2.....	1
3.....	10
4.....	12
5.....	24
6.....	22
7.....	21

toscopy are not included in this series because subsequent roentgen-ray examination demonstrated the presence of a carcinoma higher up. It is almost certainly true that there have been included, under the category of single polyps, patients who actually have had other polyps which were not demonstrable. Because of this possibility and because of the possibility of subsequent development of other polyps, each patient at the completion of treatment is advised to have a yearly proctoscopic examination and to report promptly any bleeding or change in bowel habits.

#### ROENTGEN-RAY DIAGNOSIS

The problems of diagnosis by roentgen-ray examination of polypoid lesions beyond reach of a proctoscope deserve comment. Regardless of the technical skill employed barium enema examination has a diagnostic accuracy of about 90 per cent in well advanced carcinoma of the colon. In demonstration of benign polyps this diagnostic accuracy is greatly reduced even with the valuable adjunct of air contrast examination. Frequently two or more examinations are necessary before it is possible to demonstrate the lesion responsible for the presence of gross blood in the stool.

The presence of gross blood in the stool is frequently attributed to diverticulitis of the colon. Demonstration of diverticula by barium enema is commonly considered adequate evidence for this conclusion when sigmoidoscopic and roentgen ray examination have not disclosed the presence of ulcerative disease or carcinoma. Bleeding can occur in diverticulitis, but in our experience such bleeding

usually has been found to be due to a coexisting adenomatous neoplasm.

During the past two years we have removed polypoid tumors of the colon in sixteen patients who had had a previous diagnosis of diverticulitis as the explanation of rectal bleeding. After operation there was no further bleeding in any of these patients although the diverticular disease was still present.

In eleven cases a single benign adenomatous polyp was removed by colotomy or through a proctoscope. In one patient a grossly benign, pedunculated polyp in the sigmoid was locally excised, and subsequent microscopic examination revealed a small area of malignant degeneration in an otherwise benign adenoma. In the remaining four cases obvious malignant degeneration was found at laparotomy necessitating radical resection.

Differential diagnosis is largely dependent upon roentgen-ray examination of the colon. The presence of diverticula, and particularly the presence of distortions resulting from diverticulitis, greatly increase the difficulty of demonstration of polypoid lesions. This is sometimes impossible even with repeated examinations and use of the air contrast technique. In such instances the continued evidence of blood coming from above the reach of a proctoscope is sufficient indication for exploratory laparotomy and thorough search for a probable polypoid tumor.

#### TREATMENT

Proper treatment is dependent upon accurate determination of the presence or absence of malignancy. By gross appearance a polyp may be presumed to be benign, but final diagnosis requires careful microscopic examination by a competent surgical pathologist. For this reason it is always desirable to remove the polyp in its entirety in a suitable state of preservation for satisfactory microscopic examination. Tiny sessile lesions may be destroyed by a ball-tipped diathermy electrode. This precludes microscopic examination, however, and occasionally may result in failure to recognize an early carcinoma. We have recently seen a poorly differentiated invasive carcinoma in a non-ulcerated sessile polyp 4 mm. in diameter. Small sessile polyps may be removed with a rigid wire diathermy loop in suitable condition for microscopic examination. Pedunculated tumors are usually best removed by amputa-

tion through the pedicle with a diathermy snare. In this series, excluding cases of diffuse polyposis, 211 polyps in 112 patients were destroyed by electrodesiccation through a proctoscope. Three hundred twenty-six polyps in 182 patients were removed by diathermy snare and examined microscopically. Thirteen of these, or 4 per cent of polyps in 7 per cent of the patients, were found by microscopic examination to have undergone definite malignant degeneration. Of these thirteen, nine were submitted to radical resection and in three, or 33 per cent, residual carcinoma was demonstrated in the perirectal tissue or regional lymph nodes. In four patients local excision of adenomatous polyps with small areas of malignant degeneration and long pedicles has been carried out. In one of these local recurrence of carcinoma was evident after eight months. The other three have shown no evidence of recurrence or metastases in less than two years, but the gamble has not yet been conclusively won.

#### POLYPS ABOVE REACH OF A PROCTOSCOPE

Single, grossly benign polyps have been removed by colotomy in thirty-seven patients. Twelve of these thirty-seven polyps, or one in three, showed definite malignant degeneration on microscopic examination. In six of the twelve patients with a malignant polyp only local excision was done. In each instance only a small area of malignancy was present in an otherwise benign, adenomatous, pedunculated polyp. There has been no evidence of recurrence of carcinoma in these patients a few months to several years after operation. In the other six patients with a malignant polyp radical segmental resection with removal of the regional lymph nodes was immediately carried out. In two cases the decision to perform radical resection was influenced by the fact that microscopic examination revealed malignant degeneration in a major portion of the body of the polyp. In all six patients subjected to radical resection no invasion of the pedicle could be found, but three of the six had metastatic carcinoma in the regional lymph nodes. All six patients have remained well for one to eight years.

In addition to the thirty-six patients operated upon for a single polyp four patients were explored for two separate polyps situated from 4 to 12 inches apart. In one patient both polyps were benign and were removed locally by

colotomy. In the other three patients both polyps were malignant and radical resection of the portion of the colon including both lesions was carried out. In one of the three patients metastases had occurred to the regional lymph nodes.

It is evident from these statistics that we have not been able to establish any clear criteria for determination of the necessity for radical resection in such cases. We have been fortunate to date in having elected to perform a radical resection in three patients who otherwise now would be dead from their carcinoma. The individual judgement of a surgeon cannot be infallible in determining whether malignant cells have or have not already extended beyond the local confines of a pedunculated tumor. When local excision only is selected, it must be considered to be a carefully calculated risk rather than the procedure which offers the greatest possible opportunity for cure to every patient. Although the odds may seem good, it must never be forgotten that the gamble is with the life of the patient.

#### POLYPOSIS OF THE COLON

Thirty-one patients in this series had diffuse polyposis of the colon. These may be divided into two groups: those with diffuse adenomatous polyps, with or without a familial history of disease, and those with pseudopolyposis secondary to chronic ulcerative colitis.

There were sixteen patients with diffuse adenomatous polyposis. None of these patients presented evidence of existing ulcerative disease or gave a history of previous acute or chronic colitis. Six of these patients were from three to six years of age. In two of these children colectomy was performed with anastomosis of the ileum to the rectum. This has been recommended but not yet accepted by the parents of the other four children. Ten patients were from eighteen to fifty-one years of age. Seven of the ten, comprising 70 per cent adults, already had malignant degeneration present and five of them had multiple carcinomas. Of the ten adult patients seven were treated by complete colectomy with permanent ileostomy. In two patients, with no carcinoma in the

rectum, colectomy and anastomosis of the ileum to the rectum was performed after removal or destruction of all polyps in the rectum. One of these patients has required frequent electrodesiccation of new polyps in the rectum for more than ten years. One of the seven patients with carcinoma died of recurrent malignancy. The other six are alive with no evidence of recurrence after one to fifteen years.

There were fifteen patients with pseudopolyposis secondary to chronic ulcerative colitis. Four of these patients, or 27 per cent, had carcinoma. Three of the four had inoperable carcinoma. Complete colectomy with permanent ileostomy was carried out in four patients. In one patient with chronic ulcerative colitis and pseudopolyposis involving the colon from the splenic flexure to the rectum, resection of the involved bowel was done and the transverse colon pulled through the anal canal according to the technic of Babcock and Bacon.

#### CONCLUSIONS

1. The majority of polypoid lesions of the colon and rectum are premalignant. Their discovery and eradication will prevent carcinoma in many instances.

2. Polyps are asymptomatic until ulceration results in bleeding or symptoms occur from mechanical interference with bowel motility.

3. The discovery of a polyp by sigmoidoscopic examination or the occurrence of unexplained rectal bleeding is an indication for barium and air contrast roentgen-ray studies of the colon.

4. The determination of malignant degeneration in a polyp frequently is impossible by clinical signs. Competent pathologic examination of the entire lesion is desirable for accurate diagnosis. Local excision or fulguration of a pedunculated malignant polyp does not offer the greatest possible opportunity for cure.

5. Removal of a polyp or resection of a carcinoma does not conclude the responsibility of the surgeon. Periodic sigmoidoscopic examination should be done, and roentgen-ray studies should be made whenever signs or symptoms develop which suggest the possibility of a new lesion.



# RÔLE OF THE PATHOLOGIST IN THE DIAGNOSIS OF POLYPOID LESIONS OF THE COLON AND RECTUM

FERDINAND C. HELWIG, M.D.

Kansas City, Missouri

THE pathologist, like other medical specialists, is frequently confronted with new diagnostic refinements, some of them

we often are obligated for a more careful analysis and follow-up of this by no means insignificant group of epithelial tumors which I like to designate as the histologically malignant but clinically benign group.

Unfortunately, even today too many of these lesions of the colon and rectum which show one or more foci of morphologic atypia are given the simple caption of carcinoma and the unlucky patient is subjected to unnecessary radical surgery.

## ETIOLOGY

Much has been written on the possible causative factors of colonic polypi. One school has suggested that they arise on a chronic inflammatory basis: pinworms, flukes, tuberculosis, bacillary and amebic dysentery, idiopathic ulcerous colitis, foods containing carcinogenic hydrocarbons and subclinical inflammation of submucous lymphoid follicles have all been implicated. The other school thinks that the polypi are true tumors, probably arising *de novo* from the mucosa of the bowel. It is quite true that in the chronic ulcerous lesions of the bowel the papillomatous lesions are rarely true neoplasms but are merely inflammatory poly-poid projections of otherwise normal mucosa. (Fig. 1.) It would seem that in most instances the occurrence of polyps or carcinoma in such an ulcerated gut was purely fortuitous and the same possibly holds true for the association of cancer of the bowel and diverticulosis or diverticulitis which are such common lesions in the cancer age. In my own material I have been able to demonstrate changes in the gut wall in multiple colonic polyposis in some instances which I think are consistent with the first theory although I must confess that this has been rarely possible. There is, however, no good reason that I know of which would render a colon, already the seat of multiply polypi, immune to chronic ulcerous colitis. Ewing<sup>5</sup> found in the early stages of congenital polyposis pronounced hypertrophy of the entire lining



FIG. 1. True branching polypi superimposed on chronic ulcerous colitis.

quite valuable. This is particularly true in the always puzzling so-called border-line neoplastic processes. Epitheliomas of the lip, mouth, larynx and cervix, carcinoma of the thyroid, bronchus, breast, stomach and corpus uteri, all within quite recent times have been subjected to re-study and re-evaluation. Even the early skin melanomas are being actively re-investigated for hitherto perhaps neglected but possibly important early morphologic alterations of clinical significance. In fact, recent work has been done or is under way on a surprisingly long list of histologically debatable tumors.

The increasing application of the Papanicolaou stain for nuclear variants has also served to stimulate careful study for early changes in fixed material in conjunction with these smear preparations.

Needless to say, in these re-evaluations the border-line epithelial growths of the colon and rectum have not been neglected. This study often has been forced upon us by proctologists who, in recent years particularly, are not just skillful operators but also good practical surgical pathologists. It is to these gentlemen that



of the colon, and he thinks this finding supports the view that the sole element in the predisposition is the excessive reaction of the gut epithelium to irritants. It has also been Ewing's observation that many cases preserve their inflammatory character throughout although still showing a marked tendency toward the development of malignant adenomas and carcinoma. However, it appears unlikely that such lesions as idiopathic colitis or amebiasis of long-standing would involute so completely that no histologic trace would remain in those colons with multiple polypi.

Many experiments<sup>1</sup> employing the feeding of carcinogenic hydrocarbons have failed to produce tumors of the alimentary tract. Moreover, those instances in which apparent success was obtained were not very convincing. This would seem only logical since the period of contact of any given carcinogenic agent with any single area of the gut mucosa is too brief and the agent likewise would be diluted with food. Furthermore, the protective action of mucus would also be a deterring factor to the carcinogenic agent. Barger, Cromar and Dixon<sup>2</sup> have entertained an interesting hypothesis suggesting that the site of adenoma formation is determined by the location of submucous lymphoid follicles. (Fig. 2.) These authors think that these submucous follicles, when subjected to subclinical inflammatory hyperplasia, may rupture into the bowel lumen forming a tiny ulcer. In the process of healing, epithelial cells become trapped in the base of the ulcer. Sometimes a small island of epithelium becomes isolated by a circle of lymphoid follicles which, due to progressive enlargement, have destroyed the muscularis mucosa and the epithelium becomes "pegged down" to the underlying submucosa by the lymph follicles. "Contraction of the surrounding muscularis tends to approximate these fixed points by centripetal compression and the tissue which they enclosed subsequently becomes pushed up as a little elevation above the surface of the mucosa." This little bud, they believe, represents the earliest stage in the formation of an adenoma.

In my own material I have been unable to confirm these observations, and extensive studies made by Helwig,<sup>3</sup> of St. Louis, on a large quantity of material would appear to contradict such a hypothesis. He believes that lymph nodules in the neighborhood of polypi



FIG. 2. Low power photomicrograph; early benign polyp showing lymph follicles and beginning formation of pedicle.

are purely coincidental and undergo hyperplasia as a result of inflammatory changes in the polyp. He argues that lymph nodules should be present in all polyps and that the polyps do not follow hyperplasias in other organs, such as the appendix and small intestine. He found adenomas uncommon in the negro and states that there is no evidence the negro has fewer follicles than the white man. He observed no constant location of lymph nodules in relation to areas of epithelial hyperplasia which we think represent the early stage of adenoma formation. Lastly, he mentions that lymph nodules are not uncommonly seen abutting upon lipomas and carcinoids where they could not be considered of etiologic significance.

In a more recent communication by Atwater and Barger<sup>4</sup> the latter author has abandoned the lymph nodule theory at least partially. They studied 166 colons from necropsy material which presented polypi and found only 70 per cent of the sections taken from these polypi showing lymph nodules whereas 90 per cent of pure control sections showed them. They conclude that "lymphoid structures at most seem to play only a casual rôle in the pathogenesis of intestinal polyps." Dixon, however, in a personal communication, continues to hold the lymph nodule hypothesis.

#### CLASSIFICATION AND PATHOLOGY

Binkley and Sunderland<sup>6</sup> proposed a simple yet quite adequate classification of the epithelial overgrowths of the colon and rectum which should satisfy both proctologist and pathologist. They classified them into three groups as follows: areas of mucosal hyperplasia, adenomas and papillary adenomas.



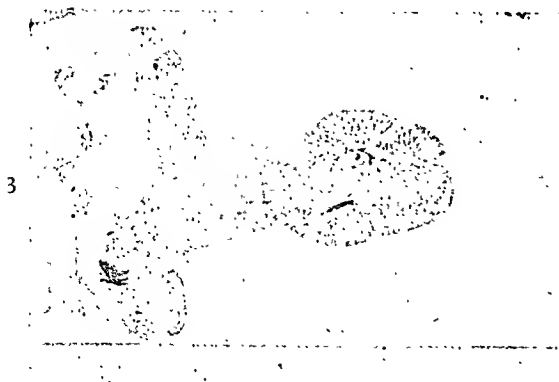


FIG. 3. Low power photomicrograph; small benign polyp with long pedicle.

FIG. 4. Low power photomicrograph; benign polyp showing arborization and basophilia.

The simple hyperplasias, as Dukcs has shown, commonly are observed adjacent to infiltrating carcinomas. They are likewise encountered on the mucosal surface of colostomies and in other areas subject to chronic irritation.

When polypi and foci of hyperplasia are present in the same bowel, it is sometimes possible to trace successive steps in the development of an adenoma. Following hyperplasia, the first step seems to be that of pulling out of the muscularis mucosa into a little hillock which carries muscularis mucosa, submucous stroma and vascular apparatus out with it, forming a small sessile protuberance easily visible grossly. (Fig. 2.) As the tumor increases in size there is more and more tendency to form a pedicle. As the pedicle elongates it usually is covered with normal or slightly hypertrophied mucosa. (Fig. 3.) The tumor itself continues to arborize and eventually may reach 3 or more cm. in diameter. As a rule, however, the tumors are relatively small and often even some of the small ones, while appearing sessile, will upon removal reveal a pedicle hidden by the overhanging borders of the adenoma. (Fig. 4.)

Grossly, adenomas are usually round, oblong or flattened, and the surface may be even or lobulated. Different tumors in the same bowel

often show a wide range of sizes and shapes. The larger growths are more apt to be lobulated. The tumors vary in color from pale gray to red depending on their vascularity, and the larger growths are more often hyperemic. When ulcerated or indurated, carcinomatous transformation should be strongly suspected. If induration is palpable at the periphery of the growth, however, it may not be clinically significant. On the other hand, when the base is indurated, malignant invasion is usually present.

Histologic variants are usually absent or minor in the very small tumors. With increasing size, changes in cell type begin to appear, the earliest being an increase in size of the crypts of Lieberkuhn, and the glands tend to become more elongated. In some very small tumors, however, cellular basophilism may be observed in tiny patches. As the tumor grows larger, the epithelial cells lining the glands may often show a cuboid shape and varying degrees of increased mucus production may also be encountered. Instead of being basally located, the nuclei tend to migrate to the center of the cell and often become more elongated. (Figs. 5, 6 and 7.)

As the arborization of the polyp becomes increasingly complex further nuclear changes begin to appear, consisting of stratification, increased vesicularity or basophilism, atypical nuclear forms and mitoses. (Figs. 8 and 9.) Atypical secondary gland formations may also be observed. In some areas we may encounter breaking through of the basement membrane and see cells passing into the underlying stroma. Many of the above changes speak for histologic malignancy. Nevertheless, when the base is not invaded and the pedicle is narrow, we are ordinarily dealing with a clinically benign lesion. However, when in addition to the signs of cellular atypia and breaking of the basement membrane, infiltration of the muscularis mucosa, penetration of lymphatic or vascular channels, or invasion of the gut wall is found, clinical carcinoma has supervened. (Fig. 10.) Varying degrees of acute, subacute and chronic inflammation and edema are quite often seen and this is much more likely to be present to an increasing degree as the tumor increases in size, and is usually much more striking when a focus of ulceration is present.

The third and least frequent type of the polyps is the papillary adenoma. These tumors may cover a wide surface. I have seen the en-

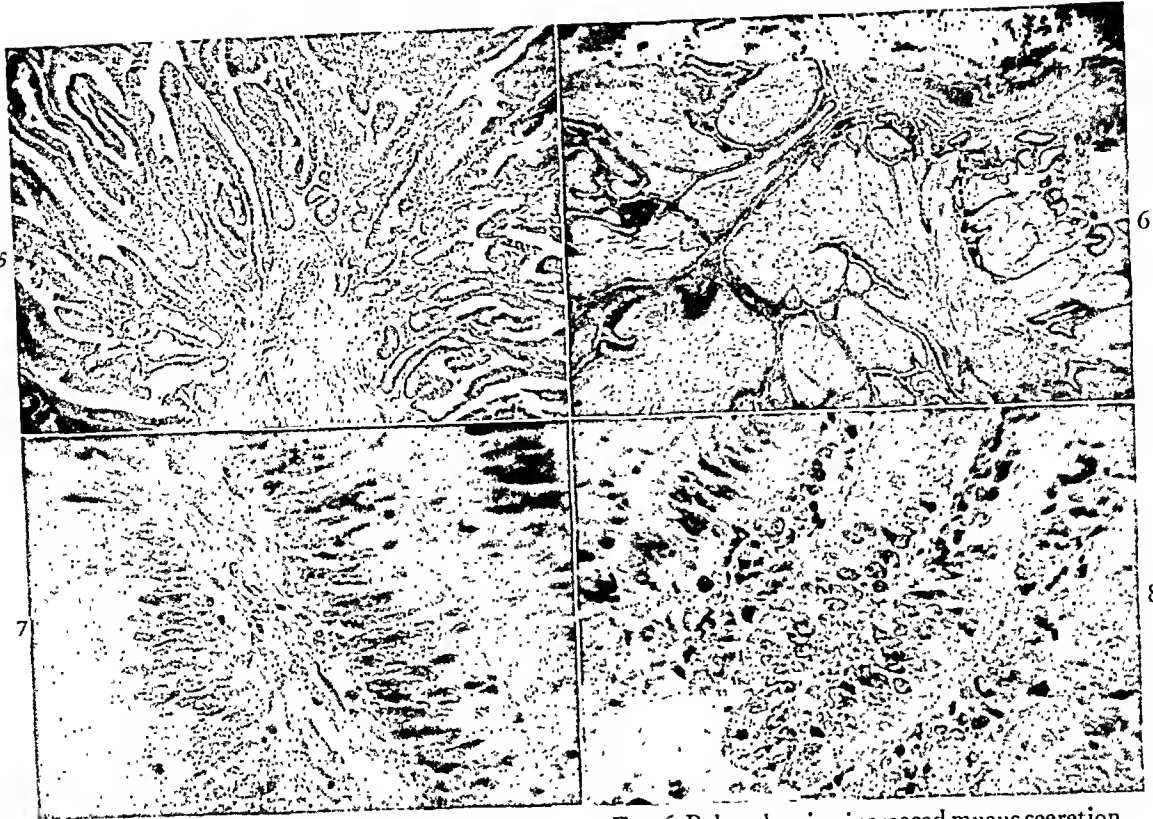


FIG. 5. Polyp showing elongation of glands.

FIG. 7. High power photomicrograph of benign polyp showing changes in nuclear form and structure.

FIG. 6. Polyp showing increased mucus secretion.

FIG. 8. High power photomicrograph; benign polyp showing changes in cell type.



FIG. 9. Low power photomicrograph; benign polyp showing piling up and irregularity of growth.

FIG. 10. Low power photomicrograph; polyp showing early malignant invasion.

tire mucosa of the rectal ampulla covered with the growth which resembled a carpet with a very long nap. The tumors may range in size from miniature growths up to those covering a very large area. When a pedicle is present, it is usually as wide as the overgrowth. When the tumor covers a zone of mucosa of medium or large dimensions, there may be a considerable variation in the thickness of the growth in different areas. Some may be as much as 3 or

4 cm. thick. The base of the growth may be semi-rounded or quite irregular. The growth on palpation is usually very soft and, as Binkley says, may not be felt with the examining finger. In contrast to the adenomas which are usually pedunculated and in which carcinoma usually arises at the border of the growth, the papillary adenomas may show early malignant changes at the base of the growth and frequently near the center of the

tumor. Invasion into the wall of the gut, the lymphatics or vascular channels may take place early. Furthermore, the zone of malignancy may not be visualized readily. Hence, this is a much more treacherous tumor and fortunately is uncommon. When these tumors are fixed, ulcerated or indurated, cancer is present in almost all instances.

Microscopically, we find the growth to be made up of many individual branching outgrowths, each carrying its own blood supply. These delicate villous processes may show any or all of the histologic variants that were mentioned under the adenomas. Even in the soft, non-ulcerated, movable tumors many of these microscopic variants may be observed at times. Hence, unless a considerable degree of anaplasia and architectural distortion exists, we must depend upon invasion as a criterion of true clinical malignancy. However, when such histologic changes do exist, induration, fixation or ulceration are almost always present although difficult at times to determine in the larger growths.

#### SUMMARY AND CONCLUSIONS

Simple hyperplasia is the first step in adenoma formation. This hyperplasia in most instances seems to arise *de novo* from normal appearing mucosa without the intervention of any demonstrable etiologic agent. In some instances, quite rare in my experience, true neoplastic polypi seem to result from long standing chronic inflammation of the gut wall. No other known etiologic factor has been convincingly demonstrated.

Adenomas with a narrow pedicle are usually clinically benign; although as they increase in size, they demonstrate an increasing tendency to show a wide range of microscopic variants which would ordinarily be captioned carcinoma on a histologic basis. When the base is involved,

we have another story. Therefore, the pathologist should be furnished with the whole tumor including the base or at least a piece of the base as well as the periphery, along with a thorough description of the gross appearance of the tumor. In the absence of these necessary requisites the pathologist has no choice in the face of histologic malignancy other than to render a diagnosis of cancer. Ulceration and/or induration of the base of the polyp usually means clinical carcinoma. This information should also be imparted to the pathologist.

Papillomas are broad based and are usually soft. They may be missed with the examining finger. They tend to cover rather wide areas of mucosa at times and as they increase in size they may exhibit the same cellular variants observed in the adenomas. Unlike the adenomas they are more apt to undergo invasive malignancy at the base. When the tumor is relatively large, foci of fixation, ulceration and induration may be overlooked. Thus, these tumors are more treacherous than the adenomas. Such indurated and ulcerated areas at the base must be biopsied or clinical carcinoma may be missed.

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# SURGICAL TREATMENT OF POLYPS OF THE LARGE INTESTINE\*

RICHARD B. CATTELL, M.D.

*Boston, Massachusetts*

THE discovery and treatment of intestinal polyps while still in a benign or premalignant state is of the utmost importance. The destruction of polyps in the lower segments by fulguration or their removal from the proximal segments by laparotomy permits local removal usually without the necessity for removal of large segments of the intestine which becomes necessary when malignant degeneration has occurred. Careful study of adults during a routine physical examination, which includes sigmoidoscopic examination and roentgenographic studies of the colon, will result in the discovery of an increasing number of these benign lesions. Major attention has been focused properly upon the detection of carcinoma of the colon and rectum in as early a stage as possible since adequate resection offers an excellent chance for cure in this stage of malignancy.

In spite of the fact that malignant lesions are being resected at a somewhat earlier time, which in our experience is approximately a two months shorter duration than ten years before and in spite of improvements in operative procedures for removal of the malignancy and reduction in operative mortality, the results observed five years or more after resection have not appreciably improved and remain in the vicinity of 50 per cent five-year survivals. The greatest opportunity in the future for the improvement of results lies in the discovery and treatment of the premalignant lesion of the colon and rectum, the benign polyp. It is encouraging to see the increased emphasis being placed on the importance of the benign intestinal polyp and it is fitting that the American Proctologic Society presents the problem further in this symposium of three papers. The previous speakers have emphasized the incidence, diagnosis as well as the pathology of these tumors and this paper will be primarily concerned with the surgical treatment of polyps.

Experiences in the treatment of polyps of the large intestine at the Lahey Clinic have been presented in several communications.<sup>1,8-10</sup> Over 1,000 polyps of the rectum and rectosigmoid have been treated while seventy-eight patients have been submitted to colotomy for removal of polyps in the proximal segments of the colon. In addition, twenty-three patients have been operated upon for congenital polyposis. No statistical analysis will be presented but general considerations will be discussed and the operative procedures that have been employed will be outlined.

## GENERAL CONSIDERATIONS

The incidence of polyps of the intestine is quite difficult to determine and depends upon the material analyzed; it has varied from 2 to 20 per cent in reported series. In autopsy series of adult patients which must be considered a selective group Swinton and Haug<sup>9</sup> found 7 per cent in 1,843 patients, or 311 with benign mucosal polyps. Helwig<sup>8</sup> found 9.5 per cent. As high as 40 per cent of patients have multiple polyps. Approximately 25 per cent of patients with malignancies have benign polyps found in the resected specimen. If one takes a special group of patients seeking proctologic consultation because of rectal symptoms, the incidence is between 5 and 10 per cent. It is probably safe to assume that at least 3 per cent of adult patients have benign polyps.

In view of the fact that only one-third of patients with benign polyps have symptoms it is immediately apparent that discovery of polyps in the remaining two-thirds of patients will be possible only when increasing numbers of sigmoidoscopic examinations are done in the routine examination of adult patients and this is recommended very strongly. This is one step in preventive medicine that offers real promise in reduction of the incidence of carcinoma of the large intestine which represents approximately one-eighth of malignancies.

\* From The Department of Surgery, The Lahey Clinic, Boston, Mass.

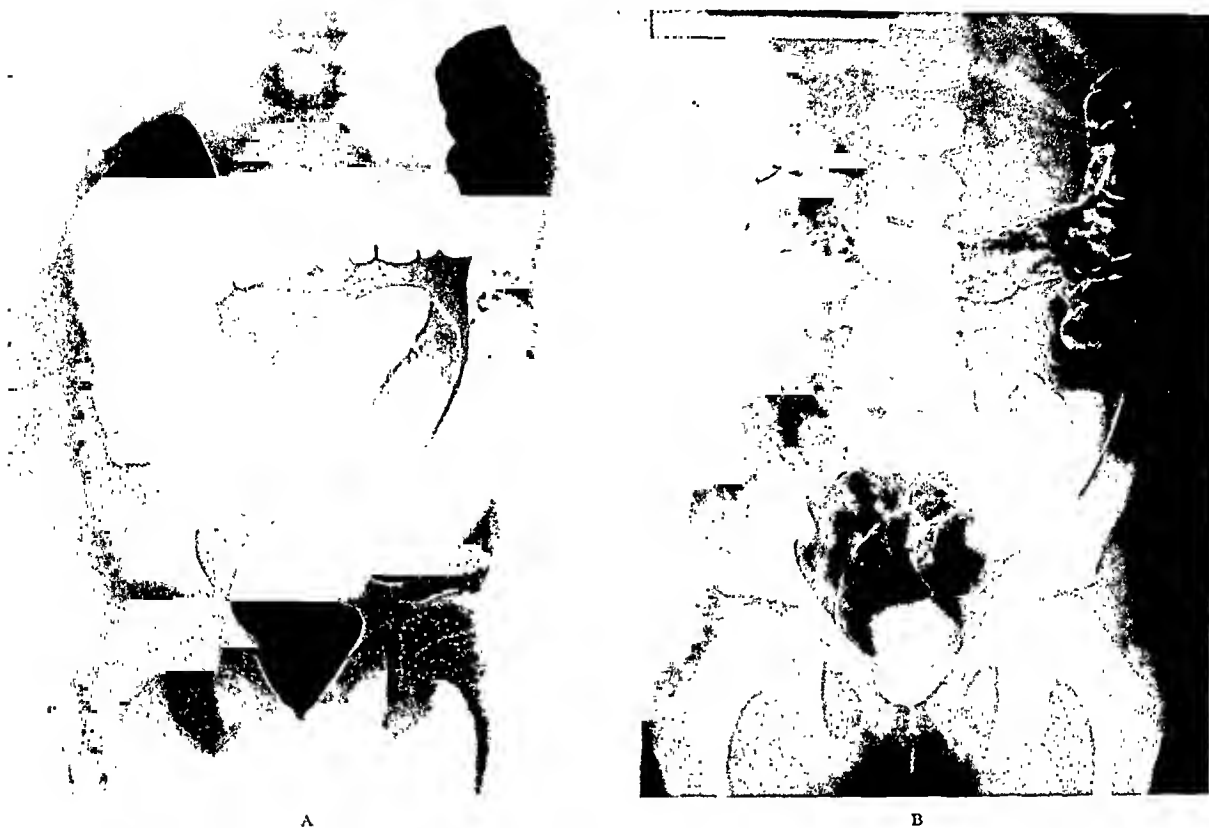


FIG. 1. A, barium enema (full) showing radiolucent defect of large polyp in descending colon; B, double contrast air enema outlining mucosal surface and pedicle of the polyp.

Intermittent or persisting bleeding is the only common symptom associated with benign polyps and this symptom occurs in only one-third of the patients. A few complain of increase in the discharge of mucus and in the occasional patient with a villous polyp a watery discharge may be present. At times, because of the large size of a polyp or because of partial intussusception, obstructive symptoms will be present.

Diagnosis of polyps of the rectosigmoid and rectum, where over one-half of them occur, should not be difficult. Adequate preparation of the bowel is essential and is best accomplished by castor oil or magnesium sulfate given the night before with cleansing enemas or colonic irrigations given one or two hours preceding the sigmoidoscopic examination. Too often attempts are made to do sigmoidoscopy with fecal material remaining in the bowel. Under these circumstances, when all of the mucosal surface cannot be visualized properly, small polyps are easily missed. Visualization of polyps in the proximal colon offers much greater difficulty. The same means of adequate preparation of the bowel are even more essen-

tial. Both the barium enema and double contrast air enema should be utilized. (Fig. 1.) We have seen many patients in consultation referred for treatment of multiple polyposis who on further examination were found to have a normal colon. The addition of tannic acid to the barium mixture in carrying out the contrast air enema is very useful. At least one repeat examination should be done for every patient discovered to have a colonic polyp to be certain that it can be visualized on second examination at the same site. This rule of repeated examinations will save the embarrassment of an appreciable number of negative abdominal explorations.

The surgical treatment of intestinal polyps can be divided into three groups: (1) polyps of the rectum and rectosigmoid, (2) colonic polyps and (3) congenital polyposis.

#### POLYPS OF THE RECTUM AND RECTOSIGMOID

The majority of polyps that can be visualized through the sigmoidoscope can be satisfactorily removed or destroyed by fulguration. It is essential that suitable equipment be available in order to do this safely. A special proctoscopic

table is necessary as well as an electrosurgical unit and strong suction. Preliminary biopsy of polyps of moderate or large size should be done routinely, but it is unnecessary to biopsy the small sessile mucosal polyps. Fulguration of polyps should be carried through the mucosa to the submucosa. It can be carried out as an office or out-patient procedure when the polyps are small or of moderate size when they are found below the peritoneal reflection. If they have a broad base or are of considerable size, they should be treated on repeated visits in order to avoid too much reaction in the bowel wall. Small polyps above the peritoneal reflection can also be fulgurated as an out-patient procedure. The broad, spreading villous type of polyp which so commonly produces a large amount of mucus requires repeated treatment and these all tend to recur. These patients must be followed for an indefinite period with repeated biopsies, but these polyps rarely tend to undergo malignant degeneration. In our experience only two of these have subsequently become malignant and required resection.

For the removal of larger polyps in the rectum and pedunculated polyps in the rectosigmoid the patients should be admitted to the hospital so that they may be observed after treatment for twenty-four to forty-eight hours. The large polyps in the rectum can be removed by surgical excision after dilatation of the sphincters or division of the external sphincter. Rarely is it necessary to close the mucosa following this local excision, but rectal dilatation may be necessary for some weeks to prevent stricture.

When multiple polyps are present, it is important to confine fulguration to a few polyps at a time because of the marked reaction that may occur.

The complications following fulguration of polyps may be quite serious. Large arterial branches may be present in the pedunculated polyps, requiring slow fulguration to secure thrombosis of the vessels. Minor bleeding is not infrequent and occasionally serious hemorrhage demanding transfusions may be encountered. The use of coagulants, such as gelfoam and oxycel, in addition to further fulguration has materially aided in reducing the incidence of bleeding following fulguration. Peritoneal reaction following fulguration of polyps above the peritoneal reflection may be evidenced by

fever, lower abdominal discomfort and cramps which may result in ileus. Actual perforation of the bowel may occur at the time of fulguration or subsequently as a result of deep fulguration. Perforation with localized abscess has occurred in two of our patients. In one patient with congenital polyposis the lower rectum was being prepared for anastomosis of the ileum to the lower segment. Unquestionably, too many polyps were treated at one time and at the time of abdominal exploration a local abscess was encountered, necessitating drainage and delay in completing the colectomy. The second patient had localized pelvic abscess which could be felt upon pelvic and rectal examination but which subsided spontaneously.

Use of the endotherm snare for the removal of large pedunculated polyps in the rectum is not without danger. It is probably best, when these polyps cannot be removed by surgical means, to destroy them gradually until the base can be properly identified when the projecting portion has already been removed. In one patient, seventy-five years of age with a large polypoid tumor in the rectum in whom we removed the polyp by an endotherm snare, we found upon further inspection with the sigmoidoscope that appendices epiploicae of the sigmoid were visible from within the peritoneal cavity at the base of the polyp. Immediate abdominoperineal resection was begun and the patient made a good recovery. There was no evidence of malignancy in this large polyp. Abdominoperineal resection may be the procedure of choice in some of these large rectal polyps even though malignancy may not be demonstrated. Earlier in our experience we performed local excisions of some of these large rectal polyps which showed malignant adenomas. Resection of the rectum was carried out subsequently because of the histologic findings, without demonstration of residual malignancy in the resected specimen. Because of this experience, we have more recently removed polyps of this type locally and followed them up carefully by repeated sigmoidoscopic examination and further biopsy and a considerable number have had no further recurrence. A series of twenty-two of these patients has previously been reported by Swinton.<sup>8</sup> If recurrence or positive biopsy is subsequently demonstrated, abdominoperineal resection is carried out.

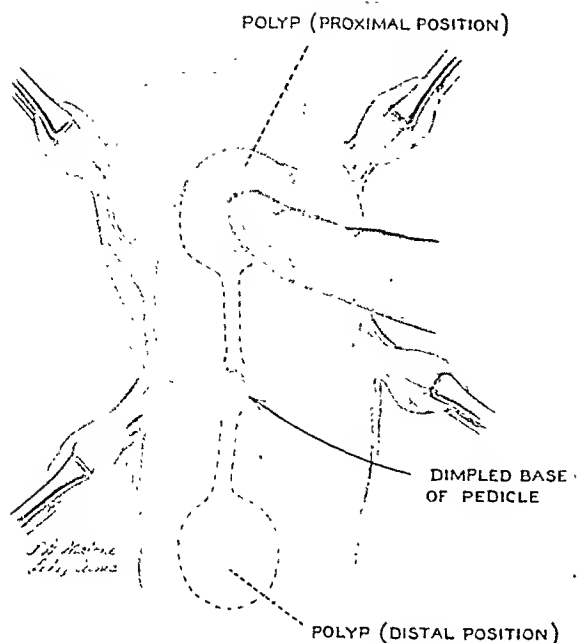


FIG. 2. The sigmoid has been freed and the polyp located. The diagram shows polyp being displaced proximally with a dimple appearing at its attachment.

#### COLONIC POLYPS

The management of polyps in the proximal colonic segments offers many difficult problems.<sup>3,4,7</sup> They are not only difficult to demonstrate by the best roentgenographic means available, but they may likewise be difficult to localize at the time of operation even after good visualization by the air contrast enema. After considerable experience we have learned that the segment containing the polyp must be well mobilized by dividing its parietal attachments so that it may be delivered outside the abdomen. This not only enables facility in palpation but also makes the operative procedure of colotomy safer.

Adequate preparation of the intestine is essential in the preoperative preparation of these patients. Single or repeated doses of magnesium sulfate followed by colonic irrigations will accomplish mechanical cleansing and emptying of the colon. We utilize sulfathaladine in 2 Gm. doses, given five times a day, for a short period before hospitalization and during the hospital preparation for surgery. It is impossible to localize accurately small polyps within the colon unless all fecal material has been removed. In one patient operated upon during the last year, in spite of the usual preparation, the colon was poorly prepared and the polyp could not be found. After further

studies to make certain that the polyp was present reoperation was necessary for its removal. Adequate preparation should avoid this disturbing occurrence.

We utilize spinal anesthesia, either with the single dose method with pontocaine weighted with glucose or fractional spinal, for carrying out operative procedures for the removal of polyps. This permits the greatest possible ease in complete exploration of all of the colonic segments which is so important in view of the multiplicity of polyps. General anesthesia supplemented with curare may likewise produce satisfactory operative conditions.

Since most polyps are located in the descending colon or sigmoid, exploration is carried out through a left rectus incision. Complete abdominal exploration is carried out. All segments of the colon are carefully explored for any possible additional lesions. In one patient a large polyp in the descending colon had been demonstrated easily without other lesions being evident in the roentgenogram. This polyp was easily felt but at the time of exploration an early carcinoma was felt in the right colon, emphasizing the importance of this careful exploration.

Particular attention is paid to exploration in the area suspected of containing the polyp. This is best accomplished after detaching the parietal peritoneum and severing the fascia propria which anchors the mesocolon posteriorly. The polyp frequently will be found some distance from where it appears in the roentgenogram either because of a long pedicle or because of distortion in the film. Palpation of the bowel is best done with the finger passed longitudinally along the bowel, pressing it back against the mesentery. (Fig. 2.) This avoids the rounded appendices epiploicae or diverticula which may be encountered and may simulate polyps. After identifying the position of the polyp this segment of the bowel may be held by four clamps or traction sutures on the appendices epiploicae. The polyp should then be displaced as far proximally as possible (Fig. 2) and the area on the bowel marked. The procedure is repeated, displacing it distally, and a point selected mid-way between the two extremes for incision into the colon. Since most of the polyps in the colon are pedunculated and can be visualized by roentgenographic means, this maneuver will greatly aid in their identification and removal. The pedicle of the polyp



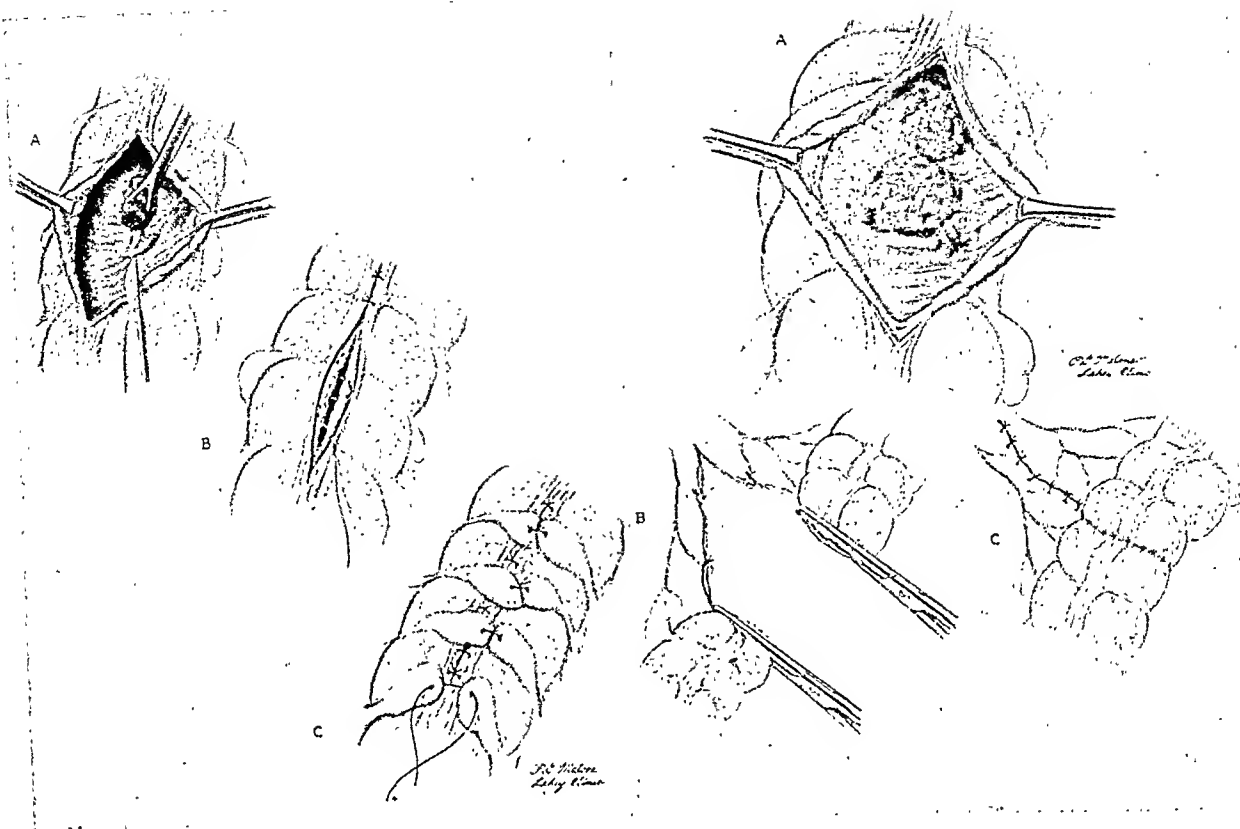


FIG. 3. A, incision has been made on the amesenteric side of sigmoid through a longitudinal band, the polyp elevated and excision begun; B, mucosa is being inverted with continuous suture and approximation sutures begun of seromuscular coat; C, suture line completed with appendices epiploicae approximated to reinforce the suture line.

FIG. 4. A, colotomy incision exposed multiple polyps; B, segmental resection performed; C, end-to-end anastomosis completed.

can frequently be felt if the attachment of the pedicle is on the amesenteric wall. When it is displaced, a dimple will appear (Fig. 2) which should be included in the incision. If it is attached to the posterior or mesenteric wall, the base cannot be definitely identified. Palpation may demonstrate induration of the base. If this is present, primary resection and anastomosis is proceeded with biopsy.

A longitudinal incision is made at the point selected, spreading the muscularis before opening the mucosa. This leaves a large amount of mucosa exposed to permit satisfactory inversion at the time of closure. The polyp is elevated and inspected, with particular attention paid to the mobility and freedom of the base. (Fig. 3A.) The pedicle is widely excised beyond a clamp, followed by suture ligation or actual suture closure, including the mucosa and submucosa. Immediate frozen section should be done with particular attention paid to section through the base.

If the polyp is large and spreading, even though it is proved benign after opening the bowel and doing a biopsy, local resection should be started with end-to-end anastomosis (Fig. 4A-C) since local excision of the polyp may be followed by stricture. If an early malignant change is noted in the periphery of the polyp but the base is entirely free, local excision is justifiable. If there is any question about it, segmental resection should be done. To complete the closure of the bowel the mucosa is closed separately with a continuous running Connell suture inverting the mucosa. (Fig. 3B.) Following this, the muscularis and serosa are approximated but not folded over with interrupted non-absorbable sutures. (Fig. 3B.) The entire suture line can be reinforced by folding over appendices epiploicae across the closure. (Fig. 3C.)

During the postoperative period we have not continued sulfathaladine. If there has been any soiling, penicillin is given prophylactically



twice a day in amounts of 100,000 units. A low residue diet is given for a few days and no enemas are given during the hospital stay. Oil can be given by rectum if necessary to obtain a movement. The use of Miller-Abbott tube intubation of the small intestine for two or

TABLE I  
COLONIC POLYPS

Descending colon and sigmoid.....	72
Proximal colon.....	6
Transverse.....	4
Splenic flexure.....	1
Hepatic flexure.....	1
Total.....	78
Postoperative deaths.....	2 (2.6%)
1 peritonitis	
1 mesenteric thrombosis	

three days may be an additional safety factor. Dilatation of the rectum with an indwelling rectal tube should be done at the completion of the operation.

It is quite important to follow these patients for an indefinite period. All patients who have had a polyp should be followed just as a patient is followed after resection for malignancy. Any patient who has had a polyp has a much greater chance of having a subsequent polyp or malignancy. Subsequent sigmoidoscopic and roentgenographic examinations are done for the first and second year after operation and later if symptoms recur.

Our experience at the Lahey Clinic in the removal of colonic polyps by colotomy include seventy-eight patients. (Table I.) The striking thing is the large number occurring in the descending colon and sigmoid, with seventy-two found in this position. Only six were discovered in the right and transverse colon, including the hepatic and splenic flexures; four were in the transverse colon while one each was removed from the flexures. This is in contrast to the incidence of polyps in these segments of the bowel found by Swinton and Haug in autopsy material. In their total cases of 311, 64 were in the right colon, 85 were in the transverse colon including the flexure and 162 in the descending colon and distal segment. This further indicates how inadequate our present methods are of diagnosis of polyps in the proximal segment of the bowel. The lesions in these cases are rarely discovered before malignant degeneration occurs with the production of typical symptoms of carcinoma. We are

badly in need of diagnostic methods to reveal polyps in this location.

During the time that these seventy-eight polyps have been removed exploration has been avoided many times when polyps were suspected or considered present but were ruled out by repeated examinations. Four additional patients had explorations, with negative findings even though it was believed that polyps had been demonstrated. One patient was subsequently operated upon with discovery and removal of a polyp.

There were two deaths following colotomy, a mortality of 2.6 per cent. Both of these occurred in 1941. No death has occurred since 1941.

The first patient was a man of fifty-four who had had blood and mucus in his stools for two months. Sigmoidoscopic examination revealed two polyps of the rectosigmoid, one of which showed signs of recent bleeding. These were destroyed by fulguration. A double contrast enema showed a polyp, 1.5 cm. in diameter, in the sigmoid. Repeat examination confirmed this finding. On April 11, 1941, the polyp was removed by colotomy and was found to have a pedicle 3 cm. in length. The base was free and frozen section was negative but subsequent permanent section showed malignant adenoma in the periphery. He developed signs of peritonitis and bronchopneumonia two days after operation. Cecostomy was performed on the fifth postoperative day but he died the following day. No autopsy was performed.

The second patient was a man of forty-seven years. He was first examined May 7, 1941, complaining of diarrhea and rectal bleeding of six years' duration. He had been treated for colitis. Three years previously hemorrhoidectomy had been performed without relief of symptoms. Sigmoidoscopic examination was negative. Double contrast air enema showed a polyp 3.5 cm. in diameter, with a long pedicle in the mid-sigmoid. The barium enema showed a large radiotranslucent area which was thought to be 5.0 cm. in diameter.

On June 4, 1941, sigmoidotomy was performed and immediate frozen section showed a mucosal polyp without evidence of malignancy but subsequent section showed a small area of adenocarcinoma. On the fourth day postoperatively he appeared to have ileus and acute dilatation of the stomach. Intubation relieved him but his symptoms recurred and

he died on the eighth postoperative day. Autopsy showed a mesenteric thrombosis of the proximal jejunum with infarction, thrombosis of the portal vein and infarct of the liver and spleen. The sigmoidotomy incision was healing satisfactorily. The cause of death was mesen-

TABLE II COLONIC POLYPS	
Previous to 1940	11*
1940	5
1941	7
1942	7
1943	7
1944	4
1945	4
1946	15
1947	13
(4 months) 1948	5
Total	78

\* Ten previously reported (Cattell and Swinton).

teric thrombosis of the jejunum. It is difficult to explain this in view of the negative heart findings unless it was caused by trauma from a retractor.

Our experience since 1940 in the treatment of intestinal polyps indicates that the number encountered is directly related to our interest in the problem and a more careful survey of patients having rectal bleeding. In Table II it will be seen that in the past three years the number treated has been markedly increased. In 1946 fifteen polyps were operated upon, in 1947, thirteen and in the first four months of 1948 five have been removed.

In view of our increasing experience and with technical improvements in operation, use of antibiotic drugs and the fact that no deaths have occurred in the past six years we believe that colotomy can at present be done safely. One problem relative to the treatment of colonic polyps remains unsettled. One-fourth of the patients who have had colotomy with removal of polyps have shown early malignant changes in the periphery of a pedunculated polyp. This is usually not discovered at the time of operation in spite of frozen sections but only in the permanent histologic sections. During the time these polyps have been removed a considerable number of patients have been operated upon with this diagnosis but at the time of exploration were found to have definite carcinoma and were submitted to resection. These have not been included in the series. A decision should be reached in the light

of past experiences whether resection should be done in all patients that show any change suggesting malignancy. Our personal experience at this time is that local excision of the polyp when there is no involvement of the base results in cure. Longer follow-up on many of these

TABLE III CONGENITAL POLYPOSIS Operative Procedure	
Ileostomy and total colectomy.....	6
Ileoproctostomy and subtotal colectomy.....	12
One-stage.....	2
Two-stage.....	5
Mikulicz.....	5
Abdominoperineal resection.....	5
Hemicolectomy and abdominoperineal.....	3
Abdominoperineal.....	2
Total.....	23

patients may show later that resection should have been undertaken at the initial procedure.

#### CONGENITAL POLYPOSIS

The management of congenital polyposis is a serious problem. These patients are usually discovered with this disease as young adults and the surgical treatment necessarily requires an extensive procedure which should include removal of all the colon and usually the rectal segment as well, making a permanent ileostomy mandatory. The condition is frequently not discovered until malignant degeneration occurs in one or more areas which may require modification of the surgical procedure of choice. Polyposis may be discovered during routine rectal examinations when irregularity of the mucosa is noted or definite polyps are palpated. Bleeding is the most conspicuous symptom and at times massive hemorrhage occurs and may continue, jeopardizing the life of the patient. The diagnosis can be confirmed by sigmoidoscopic examination and the extent of the process and the size of the polyp can be well determined by double contrast enemas. This condition unfortunately occurs as a dominant mendelian characteristic so that the majority of a family may be found to have the condition.<sup>2,6</sup> Fortunately, the condition is rare, occurring in our experience in approximately 0.5 per cent of patients with large intestinal lesions coming to operation.

Many operative procedures have been used in the treatment of congenital polyposis but most of them have been inadequate for the condition. The certain occurrence of malig-

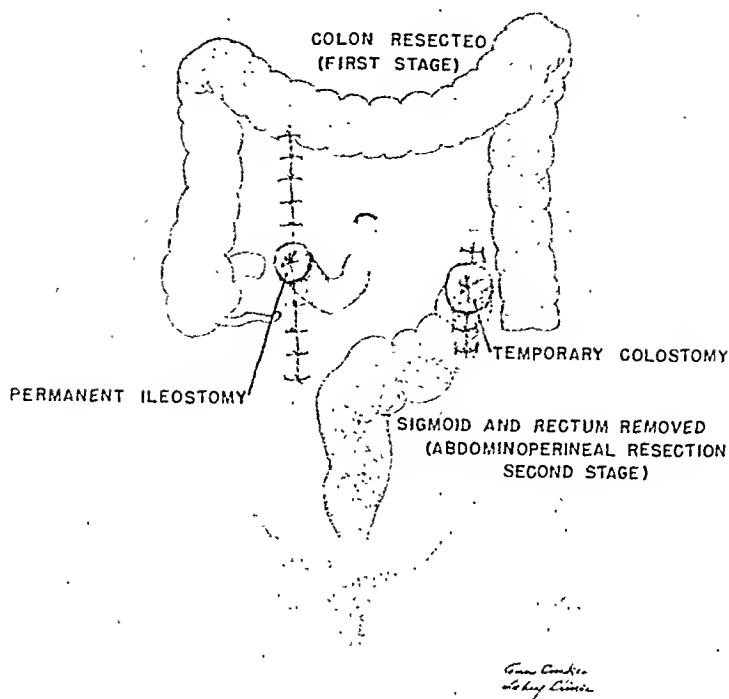


FIG. 5. Operation of choice for congenital polyposis, two-stage operation with permanent ileostomy. First stage, ileostomy established and the right, transverse and descending colon resected with implantation of the sigmoid. Second stage, resection consists of abdominoperineal removal of sigmoid and rectum.

nancy in all of these patients justifies a more radical attack than has usually been adopted in the past. Colotomy with removal of multiple polyps has been employed but has no place in the present day treatment of this condition. Local or segmental resection for larger polypoid areas or in the presence of malignant degeneration has likewise been used but is unsatisfactory. Subtotal colectomy, after destruction of as many polyps as possible in the rectal and rectosigmoid segments, has given somewhat better results but is not adaptable to most patients since the distal segment usually has the greatest involvement with polyps. *The treatment of choice is permanent ileostomy and total colectomy, including abdominoperineal resection.*

Our experience with congenital polyposis has not been satisfactory when subtotal colectomy has been employed although one patient has been followed twice a year for fifteen years without developing malignancy. In view of the present day improved management of ileostomy total colectomy is justified and recommended for all patients having congenital polyposis.

In Table III the operative procedures which we have employed are listed. In more recent cases we are employing two-stage colectomy with ileostomy as soon as they are discovered whether malignancy has already developed or not (Figs. 5A and B.) For patients on whom subtotal colectomy has been done we have used three different types of operative procedures. In two patients colectomy was done in one stage with removal of the colon and end-to-end anastomosis of the ileum to the rectosigmoid. (Fig. 6.) In three the ileum was anastomosed to the rectosigmoid as the initial stage followed by subtotal colectomy (Fig. 7.) In these five patients the operative procedures were preceded by careful fulguration of the polyps in the rectal segment. In two patients ileostomy was performed with division of the sigmoid and implantation of the distal sigmoid. In five patients subtotal colectomy was done by a modified Mikulicz procedure, doing the anastomosis as low as possible. In these five patients fulguration of the polyps in the distal segment was performed after the operative procedure since there was diversion of the fecal stream. In

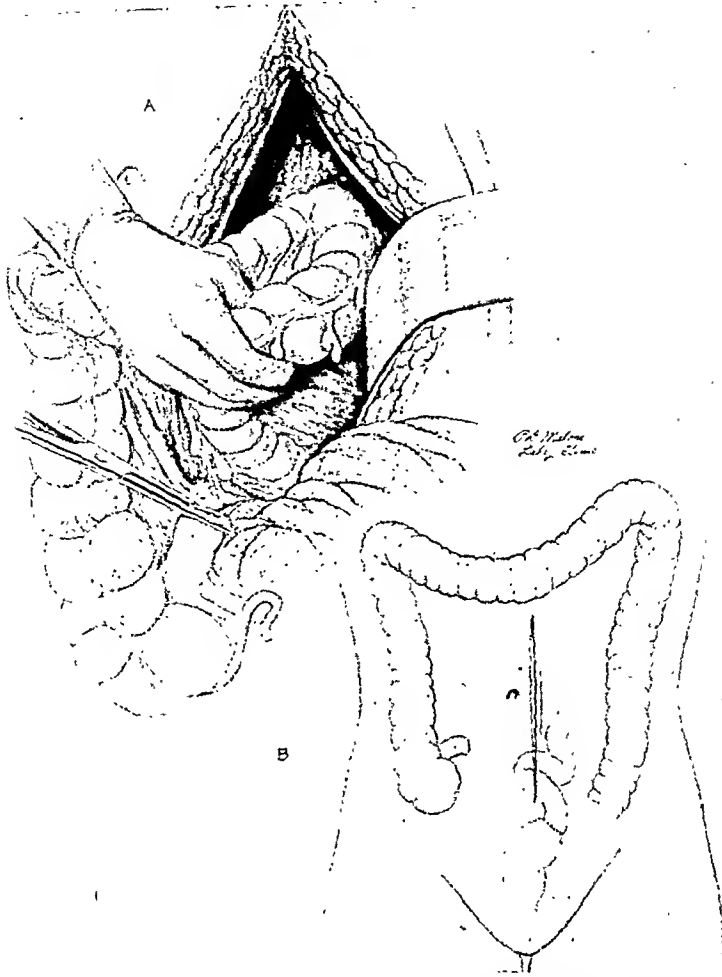


FIG. 6. Subtotal colectomy for congenital polyposis. A, ileum has been divided; the right, transverse and descending colon have been freed; B, diagrammatic sketch showing end-to-end ileoproctostomy. The shaded portion is removed.

patients with implantation of the sigmoid fulguration was carried out both through the proximal end and from below. In spite of careful follow-up in one of these patients cancer developed above the anastomosis and when the patient was submitted to resection, metastases had already occurred. Hemicolectomy and abdominoperineal resection with removal of all the colon beyond the mid-transverse colon was performed in three patients and the operative procedure limited to this in view of extensive carcinoma present in the distal segment. If recurrence does not take place within a period of two years, the proximal bowel should be removed, with the performance of ileostomy. Two patients had abdominoperineal resection alone because of extensive malignancy and both subsequently died of recurrence.

In view of this discouraging experience with the so-called conservative operations of seg-

mental or subtotal colectomy we are of the opinion that ileostomy and total colectomy should be performed in all cases.

#### SUMMARY

Intestinal polyps occur with sufficient frequency to constitute an important surgical problem.

Over 50 per cent of polyps occur in the distal bowel within visualization of the sigmoidoscope. Biopsy of these lesions should be used to exclude malignancy. They may be destroyed or removed by fulguration.

Polyps occurring in the proximal segments of the colon should be removed by colotomy. At the time of exploration frozen section should be done and, depending upon the findings, local excision of the polyps or resection of the colon performed.

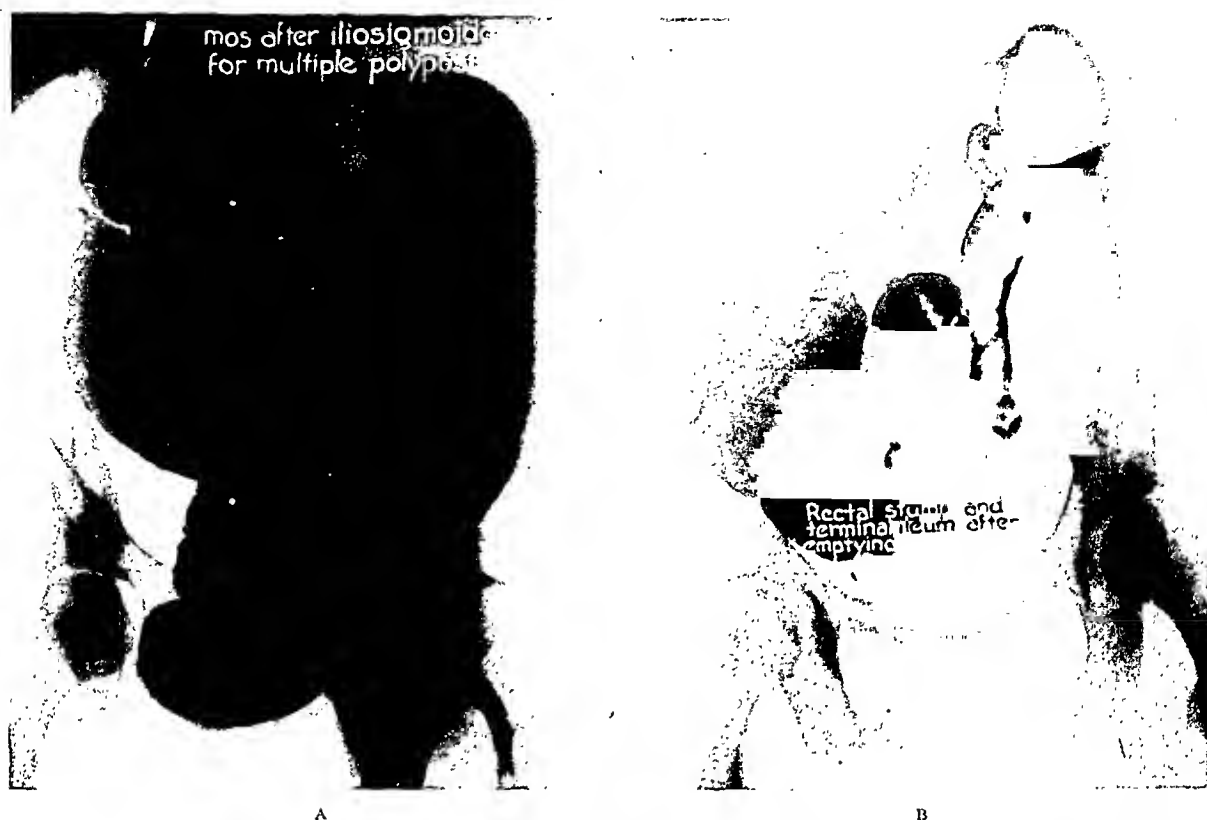


FIG. 7. Subtotal colectomy for congenital polyposis; a two-stage operation consisting of ileosigmoidostomy followed by colectomy. Patients followed fifteen years with repeated fulguration of polyps in the rectal segment. A, a full barium enema; B, empty film showing dilatation of the ileum.

Methods of localization of colonic polyps have been demonstrated and the technique of removal illustrated.

A series of seventy-eight colonic polyps removed by colotomy are reported. There were two operative deaths, a mortality of 2.6 per cent.

All patients who have been treated for intestinal polyps should be followed carefully by repeated sigmoidoscopic and roentgenographic studies for an indefinite period. They have a higher incidence of subsequent malignancy than normal individuals.

Surgical treatment of twenty-three patients with congenital polyposis is recorded. The operative procedure of choice is ileostomy and total colectomy in two stages.

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DISCUSSION OF PAPERS BY DRS. SCARBOROUGH AND KLEIN AND DR. HELWIG AND DR. CATTELL

CLAUDE F. DIXON (Rochester, Minn.): It has been my belief, after the teaching of the late Dr. Robertson, that if one has an epithelial hyperplastic polyp of the colon and lives long enough

it will practically always become malignant. This action may take a number of years. I have no idea of guessing at the length of time required for a true epithelial adenomatous polyp to become malignant. It is worth emphasizing that 18 to 20 per cent of the segments removed because of carcinoma will show small polyps 5 or 6 cm. away, usually cephaled, from the original carcinoma. Why these develop I do not know but it is true that polyps do occur in fairly close proximity in about one-fifth of those patients in whom cancer of the colon is removed, particularly on the left side.

It is not always easy at the time of operation to find a polyp in the bowel, as Dr. Cattell and others have mentioned, especially if the polyp is of the soft, papillary or villus type. Some years ago I began using a Cameron cold light to transilluminate the bowel, and that procedure has saved me a great deal of embarrassment on many occasions. By such a method as Dr. Helwig demonstrated microscopically I have been able by using an infra red camera to photograph polyps before the bowel was opened and to demonstrate a blood vessel running up the pedicle and out into the periphery of the lesion.

Regarding familial or congenital polyps, I must say that my experience—perhaps wrong—has been somewhat divergent from that of Dr. Cattell. When the proctologist is able to fulgurate the polyps in the rectum and rectosigmoid and does not find an ulcerating carcinoma, I have carried out a subtotal colectomy with, as he demonstrated, an anastomosis between the ileum and the rectosigmoid. This is done as a rule in two stages. I have found that if the fulguration process is carried out first the bowel becomes white and thickened, and an anastomosis is difficult and may be fraught with danger; therefore, I have made such anastomoses truly in myriads of these polyps, and fulguration by the proctologist has been carried out later. Perhaps some of these will recur as Dr. Cattell has stated. I am certain that only time will answer that question. Some of my patients treated in this manner have lived ten or twelve years.

That the true epithelial pedunculated polyp will become malignant if the patient lives long enough is demonstrated by the following two examples:

The first patient was told he had a polyp which accounted for the intermittent bleeding. Surgical treatment was refused. Seventeen years later he had an ulcerating carcinoma in exactly the same place as the polyp; the carcinoma was removed. He did not have metastasis and made an uneventful recovery. The second patient had a polyp in the descending colon. He, too, refused surgical treatment which, as Dr. Cattell said, should have been colotomy. When he returned to the clinic four years later, a definite filling defect caused by an

ulcerating carcinoma was found upon roentgenographic examination of the colon. A segmental, two-stage resection was carried out and recovery followed.

Carcinoma superimposed upon polyps of the colon in which long-standing chronic ulcerative colitis has been present has interested me for a long time. I am not at all certain that I have a clear conception of the condition except that, in so far as I know, lesions of a malignant nature occurring in the colon of a patient who has had long-standing ulcerative colitis are usually of high grade (grade III or grade IV). We have had only a few patients live more than five years. Most of them die within three years. The question comes up then: Where and why does the cancer develop? Some have stated that it develops from the polypoid tissue between the ulcerated areas. I have seen such lesions but at the present time I am of the belief, from what I have been told and from what has been demonstrated to me, that such malignant lesions frequently occur at the edge of the ulceration and not, as a rule, on the hyperplastic epithelial polyp as Dr. Helwig so clearly demonstrated here. I may be wrong in my conception of this, but it is sufficient to say that in a number of patients who have ulcerative colitis cancer develops.

In conclusion, I should like to say that if we knew why a polyp undergoes malignant change certainly we would have a good start in learning the cause of cancer.

GEORGE E. BINKLEY (New York, N. Y.): I should like to limit my remarks to polyps of epithelial origin. There is little room for disagreement with the three authors. However, a number of points are worthy of emphasis. It is gratifying to hear Dr. Scarborough's and Dr. Helwig's classification because they are recognizing more than one type of adenomatous polyp.

We have no proof in our clinic that the areas of hyperplasia become malignant, but I am inclined to have the same suspicion as Dr. Helwig that these areas may at times be the primary focus of non-malignant polyps or intestinal cancer. The adenoma and the papillary adenoma are definitely precancerous lesions and will become malignant if not removed.

Dr. Scarborough's report on malignant nodes in cases of malignant adenoma attached to the colon wall by a pedicle is very interesting. So far we have not found any cases of this nature in our series. One must agree with Dr. Scarborough that papillary adenomas are not a group of innocent polyps. While a fair percentage will be found to be non-malignant, many others will show atypical changes or definite cancer. He found 30 per cent with malignant change; we found 68 per cent with malignant change. This high percentage was encountered either at the time the patient came

under treatment or malignancy developed in polyps that were not completely removed. It required twelve to fifteen years in some instances for the malignant change to occur.

Everyone seems agreed that polyps of the colon and rectum are occurring more frequently. Therefore, greater emphasis should be given to diagnosis. I agree with Dr. Cattell that the colon must be clean if these lesions are to be recognized. It is not always possible to cleanse the colon thoroughly for a barium enema investigation with a one-day preparation. We are taking two and three days for preparation in many cases and find the addition of tannic acid to the barium a valuable asset. The majority of lesions situated in the lower sigmoid and rectum are easily recognized by proctoscopic and sigmoidoscopic examinations. The lower sigmoid should always be inspected when polyps are suspected. I have removed a polyp through the proctoscope, from the sigmoid, in two patients who previously had been subjected to laparotomy for rectal bleeding. Adenomas within reach of the sigmoidoscope may be removed, as stated, by fulguration or electric snare. We prefer snare removal to fulguration.

The treatment of papillary adenomas of the rectum is a real problem. I believe Dr. Scarborough removes a number of them with the electric snare. Dr. Cattell mentioned surgical excision. There is no routine method for removing these wide-based polyps. The treatment of choice may be removal with electric snare or removal with electric snare followed by radiation therapy, surgical excision or partial or complete resection of the rectum. Each patient presents an individual problem. At times in these elderly people it seems wiser to treat the patient in a palliative rather than a radical manner although the disease by the palliative method may never be completely eradicated.

It would like to emphasize the importance of a clean bowel in all those who require colon surgery. The type of colotomy advocated by Dr. Cattell is suitable in the majority of cases. In the more extensive disease we are using the Mikulicz procedure and local resection with end-to-end anastomosis while colectomy is the method of choice in cases of multiple polyposis.

FREDERICK B. CAMPBELL (Kansas City, Mo.): I believe that qualified proctologists for the most part give adequate treatment to those who reach them, but their usefulness may be extended if the importance of early diagnosis and the simplicity of treatment were frequently discussed at staff meetings, county society meetings and state meetings. All practitioners should be made more aware of the importance of blood in the stool and taught the use of the sigmoidoscope. As more internists employ sigmoidoscopy as a part of the general physical examination more asymptomatic polypoid

lesions can be found and proper treatment advised. This could be made an important phase of the cancer detection program, if efficiently carried out, and in my opinion in many cases we would have cancer prevention rather than cancer detection.

I had the privilege of reading Dr. Scarborough's paper prior to this meeting and I found nothing with which I could disagree. We have not noted the local recurrence of polypoid lesions removed by fulguration such as reported by Dr. Scarborough; however, this may be due to inadequate follow-up on our patients since we have had recurrences in clinically and pathologically malignant polypoid lesions which were fulgurated when major surgery was not advisable. In treating these lesions the error should be on the side of overtreatment rather than on the side of undertreatment.

We have also noted lymphoid elevations, as we assume them to be in those with anorectal infection, which cleared up when the infection was removed. Dr. Scarborough's remarks on bleeding in diverticulosis should also be remembered, and we should not assume that no polypoid lesion is present when the x-ray is negative.

Except in unusual or in those we consider doubtful cases, we now very seldom secure a biopsy specimen in a pedunculated polypoid lesion showing no ulceration and which is of such a size and location as to be suitable for removal as an office procedure. We have simply assumed that we are dealing with either a very early malignant lesion or a premalignant lesion, and our method of treatment would rarely be influenced by the pathologic report.

Not only may a normal rectum or sigmoid be sacrificed by improper evaluation of the clinical findings and of the pathologic report but another grave injustice may result. In insurance matters, for instance, when a diagnosis of carcinoma becomes a part of the record, the insurance company has no way of knowing that adequately fulgurated lesions do not recur and an individual actually has become a better risk.

The pathologists can be our greatest comfort when we are troubled by indecision. I have sent tissue from the operating room to Dr. Helwig's laboratory. He has then come to the operating room to learn something about the history of the patient and the exact source of the specimen presented before making his diagnosis because he realizes that he is to influence an important decision. That is one indication of a good pathologist.

I should like to mention use of the electric snare only to condemn it for general use. In the hands of the untrained and the inexperienced it is an exceedingly dangerous instrument when applied above the peritoneum. For those who have learned its use the hard way it can be a handy tool, and on rare occasions it can be useful—but it is dangerous.



I believe its use should be discouraged for lesions above the peritoneum.

It is not amiss again to emphasize that in large polypoid neoplasms, as mentioned by Dr. Cattell, it is, as a rule, much safer to do repeated fulgurations rather than attempt to complete the operation at one time. The greatest caution should be used in treating children in whom the bowel wall is extremely thin.

I have had the same experience as Dr. Cattell had in the removal of a large polypoid tumor in the rectum which required immediate resection; in that case our custom of preparing the bowel in all such cases, as it is for any resection, paid off well. I must agree with Dr. Cattell who believes that polyps of the rectum and lower sigmoid should be fulgurated before the ileosigmoid anastomosis has been done in diffuse polyposis requiring subtotal colectomy. The line of anastomosis must go through the mucosa containing polypi, some of which may already be undergoing early malignant changes, and fulguration of the anastomotic line with its questionable blood supply and scar tissue could be hazardous. If the anastomosis is done too high, additional adhesions and fixation of the lower segment may make it difficult or impossible properly to visualize the anastomosis from below and the discharge of ileal contents adds to the difficulty.

Unless there are urgent contraindications, it has been my experience that it is easier to fulgurate before surgery; then it may be possible to save more of the sigmoid than one would dare to do otherwise, and the anastomosis can be done without fear of including a polyp in the suture line.

A hereditary factor is recognized in diffuse polyposis of the familial type. May not the same factor apply to discrete polyposis?

I have a small series of cases in which one or more polyps were found in individuals who came in for rectal examination because the parent had carcinoma of the rectum or sigmoid. I believe we should advise such an examination of the sons and daughters of cancer patients.

Dr. Binkley mentioned the usefulness of a temporary colostomy for the removal of several polyps from the descending or transverse colon. On several occasions we have done a temporary colostomy for the removal of several polyps by fulguration through the sigmoidoscope, and in this way small polyps not shown by x-ray may be fulgurated. In selected cases this may not be too large a price to pay for minute observation under direct vision.

DOUGLAS A. SUNDERLAND (New York, N. Y.). Being a pathologist, I naturally am extremely interested in the papers of Dr. Scarborough and Dr. Helwig. I do not believe that I am qualified to venture any opinion on the causative relation between areas of hyperplasia and incidence of

carcinoma of the bowel. I have not done much work in that line. I am chiefly interested in the remarks that were made on papillary adenomas. Our figures at Memorial, in our series of forty-eight cases, very closely approximate those of Dr. Scarborough. He has an incidence of 30 per cent of carcinomas arising from papillary adenomas and, as Dr. Binkley said, we found 68 per cent of the patients to show *in situ* carcinoma. Only 39 per cent showed actual invasive carcinoma.

I am certainly in very great accord with both Dr. Scarborough and Dr. Helwig on their statements that a pedunculated adenoma in which an area of carcinoma is present should be considered as a clinically benign lesion if the muscularis mucosae of the pedicle is not invaded. I think in all such cases that we have had we have not as yet seen metastasis unless the muscularis mucosae of the pedicle was invaded.

In contrast to Dr. Scarborough's statement that most of the areas of carcinomatous change in papillary adenomas occur in the base, we found it to be about equal in all parts of the tumor—many times in the superficial and central portions as well as the base and in some cases in multiple areas throughout.

I was also very much interested in the excellent photomicrographs shown by Dr. Helwig, and especially interested in one of his pictures where he showed cystic dilation of the glands in one of the adenomas. We have noticed this very often in papillary adenomas and we have also noticed that in the carcinomas that arise in papillary adenomas we have a much higher proportion of colloid cancer than is found in rectal and colonic carcinomas as a whole. This led us to wonder if the cystic dilatation and excess mucus production had any relation to the appearance of colloid carcinoma but unfortunately we were not able to establish any correlation.

I should like to repeat what Dr. Binkley mentioned about the malignant change in papillary adenomas. Even though there were areas of invasive cancer within the substance of the polyp we have seen no distant metastasis unless the bowel wall itself were invaded.

NEIL W. SWINTON (Boston, Mass.): This symposium illustrates an apparent fact, that is, the importance of the cooperation of the clinician, radiologist and pathologist.

We have been impressed with the number of patients referred to us with rectal tumors who had had a biopsy specimen taken, the slides sent along with the patient and the patient had been told he had cancer. I cannot give you accurate figures, but in a surprising number of those patients we have failed to agree with the diagnosis of cancer. We have repeated the biopsies and have carried out exhaustive studies in these cases and have decided



against radical resection. There may be a tendency to perform resection in too many of the borderline cases of rectal polyps.

All of us who are doing clinical work, particularly biopsies, must confer carefully with the pathologist. Many times the diagnosis of malignant disease cannot be settled at the time of immediate section; the late sections must be studied. I usually go to our laboratory, sit down with the pathologist and go over every angle of the patient's record and all of the findings before I make a final decision for or against radical resection in the borderline cases.

One other thing with regard to the roentgenologic examination—it has been pointed out repeatedly that it is not easy to diagnose small tumors in the rectosigmoid region. As an experiment during recent months I referred to our radiology department 150 patients on whom I had carried out proctoscopies. In that group I found fifteen patients with tumors that I could see. With every known means at the radiologist's command, repeated examinations, both barium enema and contrast films, with separate preparation on different occasions and knowing that the tumors were there before he began the examination he could confirm the diagnosis of tumors in only five of the fifteen patients.

ALBERT G. SCHUTTE (Milwaukee, Wis.): In the past two years I observed two male patients, nineteen and twenty-two years old respectively, who had had subtotal colectomy and ileosigmoidostomy for familial polyposis. In one instance the patient had abdominal metastases and an inoperable carcinoma of the lower end of the sigmoid near the stoma. The other patient had not been observed in two years but had had an ileosigmoidostomy done eight years previously. He had been married in the last two years and he failed to report for observation; when he did, an early adenocarcinoma was found in the blind end of the remaining sigmoid which necessitated resection of the rectum and permanent ileostomy.

These cases emphasize that if an ileosigmoidostomy is done and the rectum is left the patients must be observed regularly and continuously for the rest of their lives while if the rectum is removed you can forget about it. This is something to think about.

G. M. BROWN (Bay City, Mich.): This argument as to whether we should use a snare or whether we should fulgurate leads us to think that both methods are useful. The difficulty comes in whether or not we know the machine we have it attached to.

I have had experience with four or five different machines in the course of the past twenty years and I have found it quite necessary to obtain a piece of liver or beef kidney from the meat market and put the different electrodes on it to find where to set the machine before I put it on the patient. I think that

is a point we should pay attention to before starting to use a machine we are not familiar with.

ROBERT A. SCARBOROUGH (closing): In regard to colotomy for a single polyp we believe that the preoperative preparation for such an operation should be equal to that for resection of a carcinoma since we are never certain before operation whether or not such a resection will be necessary. We always have a pathologist present in the operating room to observe the gross specimen and to make a frozen section diagnosis.

In regard to polyps that we think are malignant but which have pedicles which show no involvement I should like to repeat that we have had four patients in whom such polyps, with at least 2 to 4 cm. of uninvolved pedicle, had regional lymph node metastases.

In regard to colectomy I agree with Dr. Cattell that removal of the entire colon is certainly the theoretically correct procedure. In a manner of our patients, however, there have not been many polyps in the rectum and if anastomosis is done by an end-to-end procedure between the ileum and the rectum not high up in the sigmoid it is possible to proctoscope the entire area of residual rectum, in fact, to pass the proctoscope on into the ileum. If these patients are carefully followed, I believe that further development of polyps can be controlled in probably most of them without development of malignancy.

In regard to the argument between the snare and the diathermy ball tip certainly both instruments are of value, and their usefulness depends upon the experience of the individual using them. However, my vote must go with Dr. Binkley and the diathermy snare and my decision is weighted principally by the fact that ideally every bit of adenomatous tissue removed from the rectum should be examined microscopically for malignancy, and in the destruction by diathermy microscopic examination is not possible.

RICHARD B. CATTELL (closing): I wish to congratulate Dr. Helwig on his presentation. He has studied the problem of malignant degeneration in polyps over a long period of time and his work and the work of others is the basis for the treatment of polyps at present.

I appreciated Dr. Dixon's emphasis on the importance of malignant degeneration in inflammatory diseases of the colon. In long-standing cases of ulcerative colitis at the Mayo Clinic they have reported a large series of cases which I think probably exceeds seventy-five patients who have had malignant degeneration. We have had nineteen and the results of treatment in our patients is even more disastrous than Dr. Dixon reported. We have two living of nineteen and in these two individuals the carcinoma was discovered by the pathologist at the time of total colectomy for other indications.

In all patients in whom malignancy was clinically proved death resulted from malignancy.

If we are to avoid this most serious complication occurring in patients with long-standing ulcerative colitis, the number of patients having total colectomy must be increased. Furthermore, any patient who has had ulcerative colitis who has had a clinical remission of symptoms and then begins to have rectal bleeding must be considered a carcinoma suspect.

I think it will take considerable courage for us, the surgeons, to continue to accept local excision of polyps by colotomy in light of the information which Dr. Scarborough has just presented. It is possible we will have to revise our opinion if others substantiate the presence of glandular involvement when the base of the polyp is free of malignancy. Thus far, we have not observed it and I do not believe it has been previously reported.

Relative to congenital adenomatous polyposis, I stated that the operation of choice is ileostomy followed by total colectomy, but I agree with Dr. Dixon and Dr. Scarborough that there are selected cases in which there are a limited number

of polyps in the rectum that can be treated by fulguration, making it possible to do subtotal colectomy. These patients must be followed at least every six months for the duration of their life by sigmoidoscopy and fulguration of any polyps that are discovered.

In view of the frequency with which polyps are discovered in segments of the colon resected for carcinoma we must continue to be on the lookout for multiple lesions, both benign and malignant.

At a time when many more modified Mikulicz resections of the colon were done we frequently used sigmoidoscopic visualization, as mentioned by Dr. Binkley, in both proximal and distal ends of the projecting colostomy. Similarly, the instrument may be introduced into an end colostomy following abdominopcrineal resection to rule out the presence of polyps of the colon.

Approximately 4 per cent of the patients who are operated upon for carcinoma of the colon or rectum in our clinic have two or more malignancies and we must continue to emphasize the possibility of this occurrence in order that a second malignant lesion will not be overlooked.



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# Case Reports

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## RETRORECTAL PARAGANGLIOMA WITH METASTASIS

VINCENT T. YOUNG, M.D.  
Washington, D. C.

ACCORDING to Dr. Samuel P. Hicks, paraganglioma is a generic term applied to tumors of the paraganglions of the sympathetic and peripheral nervous system. Paraganglions are, like the sympathetic nervous system, derived from the embryonic neural crest. The best known paraganglions are the adrenal medulla and the carotid body, but similar chromaffin tissue is found in association with other parts of the peripheral nervous system and in the form of enterochromaffin cells in the intestinal and bronchial epithelium. The best known paraganglioma is the carcinoid while much less frequently encountered tumors are the carotid body tumor and the pheochromocytoma of the adrenal medulla. Paragangliomas may arise anywhere in the peripheral nervous system but aside from the carcinoid of the gut they are rare. In general these tumors tend to remain benign but malignant forms occur with metastases. It is probable that the tumor described herein originated in the anococcygeal body.

### CASE REPORT

E. G. G., a thirty year old male veteran, was admitted to the hospital on January 12, 1946, complaining of severe pain in the lower rectum and coccygeal region. He traced his first symptoms back to 1935 when he had a minor fall on the sacrococcygeal area following which he suffered sharp pain in that region for a week. This subsided without incident. Six months later he became conscious of a dull ache in the vicinity of the coccyx, a sensation of fullness in the rectum and a feeling of incomplete evacuation. Several months following the onset of these symptoms the pain suddenly became so excruciating that it was necessary for the patient to go to bed. A physician examined him at that time but nothing was found to explain the pain. After a week the severe pain subsided and only the dull ache and sensation of rectal fullness remained. From this time exacer-

bations of intense pain would occur once every three to six months. During several of these episodes physicians were consulted but no physical findings were revealed to explain the symptoms. When the patient entered the armed forces in July, 1942, no physical disabilities were noted on the induction examination. While in the service the symptoms increased in severity and the exacerbations of acute pain became more frequent so that it was necessary for the patient to be placed on the sicklist on numerous occasions. Cause for his complaints was not found during these periods of hospitalization. When he was discharged from the Army on November 4, 1945, no physical disabilities were noted. Two months later, January 10, 1946, a civilian physician was consulted during another bout of pain and on digital examination a large mass was found bulging into the rectum (digital examination had not been performed previously). There was no loss of weight or bloody stools. Family history was negative for tumors. A complete systemic inquiry did not contribute anything of further interest.

The patient, a slender, white male, gave the appearance of suffering acute pain. On admission his temperature was 99.2°F., pulse 88 and respiration 20. Digital examination revealed a large mass bulging into the rectum posteriorly which extended to the external sphincter below and followed the curve of the sacrum higher than the finger could reach. The mass was hard and firmly fixed. No fluctuation could be elicited. Proctoscopic examination showed the mucosa to be unbroken and normal in appearance. The sedimentation rate was moderately increased; blood and urine tests were within normal limits. X-ray examination did not reveal a tumor mass or evidence of bone destruction. A complete physical examination was negative. The impression at that time was that the patient was suffering from a retrorectal teratoma.

On January 18, 1946, an operation was performed under spinal anesthesia. The coccyx was removed through a posterior incision. A large hard, fixed mass was found which bulged into the rectum anteriorly. Laterally, it completely occluded both ischiorectal fossae. Below, it extended

to the external sphincter muscle. Above, the mass followed the curve of the sacrum for 10 cm. The tumor was freed with difficulty from the surrounding tissues to which it was densely adherent. It was necessary to resect a small portion of the posterior wall of the rectum about an inch and a half above the external sphincter muscle because the tumor could not be dissected free at that point. The bowel was closed and the wound packed open.

The pathologic examination was performed by Dr. Samuel P. Hicks who reported the following: The tumor was an encapsulated, round mass of firm tissue about 9 cm. in diameter in the fresh state. On section it was fairly homogeneous being composed of ill defined masses of pale brown tissue in a fibrous matrix.

The tumor was composed of islands of small, closely packed epithelial cells embedded in connective tissue. These cells, whose cytoplasm showed an affinity for potassium bichromate, were rarely arranged in acinar formation, usually appeared in sheets and tended to be radially palisaded at the peripheries of the islands. The nuclei and cytoplasm were fairly uniform. Histologically, the tumor appeared benign. The diagnosis was paraganglioma.

The postoperative course was somewhat complicated by a breakdown of the bowel repair. However, after three months the fistula had healed spontaneously and without further incident. Four months following operation the patient was enjoying complete freedom from his symptoms and weighed 20 pounds more than his best previous weight. On May 20, 1946, he suddenly developed an acute suppurative pyelophlebitis. The origin of this is obscure but was thought to be on the basis of a pelvic phlebitis. The patient recovered following a stormy course which lasted a month and a half. He continued in good health until November, 1946, when he first noted swelling and pain in the lumbar region. Shortly thereafter pain began to radiate down both legs and became

progressively worse. X-rays of the spine showed an area of rarefaction in the third lumbar vertebra. Pantopaque studies revealed obstruction between the third and fourth lumbar segments. Reflexes of the lower extremities were diminished, sensation was gradually lost and the legs became paralyzed. On March 18, 1947, a laminectomy was performed and a small extradural tumor involving the third lumbar segment was removed. Pathologic examination of the specimen showed a histologic picture similar to that previously described.

Following this operation all symptoms rapidly cleared up and only slight numbness of the right leg remained. However, after two weeks the same symptoms gradually began to reappear and became increasingly worse until complete paralysis of the lower extremities again resulted. Further study revealed a cord compression in the thoracic region. On April 19, 1947, a second laminectomy was performed and a small extradural tumor was found compressing the cord at the seventh thoracic level. This also presented a microscopic picture similar to that of the original tumor.

The patient made an excellent recovery from this operation and remained well until December, 1947, when he again presented signs and symptoms of cord compression. On January 19, 1948, a small growth was removed from the second and third lumbar segments which was assumed to be a recurrence of the tumor previously removed from this region.

#### SUMMARY

1. A case of retrorectal paraganglioma with metastases has been presented.
2. It is probable that this tumor originated in the anococcygeal body.
3. A search through the literature did not reveal a similar case.



# ANOMALOUS DEVELOPMENT OF ANAL PAPILLAE

HERBERT I. KALLET, M.D.

*Detroit, Michigan*

**A**LTHOUGH many types of congenital malformations of the anus and rectum have been described, there has been no abnormality, congenital fibrous bands at the anterior or posterior commissure may be present, producing some degree of anal stenosis.

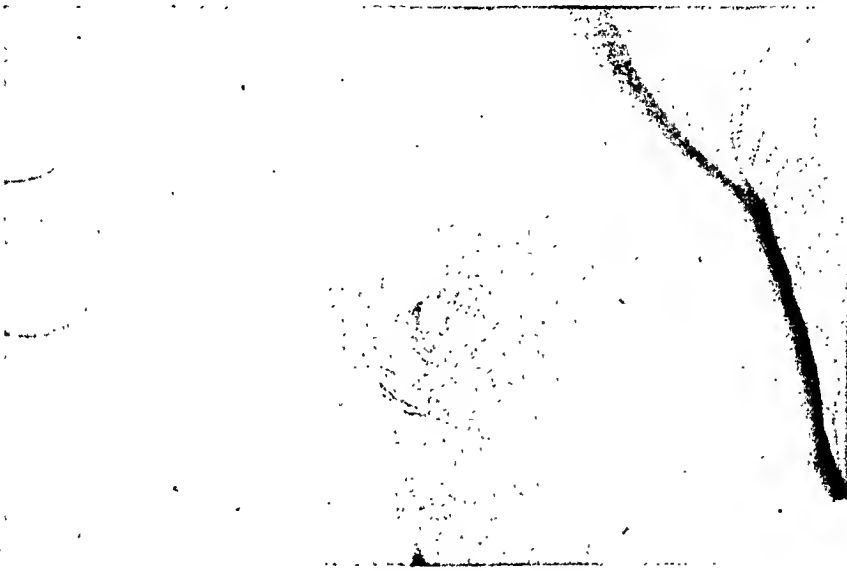


FIG. 1. Girl, eight years of age with two abnormally developed anal papillae.

mention of anomalous development of anal papillae. During the past two years I have observed eight children in whom this type of maldevelopment was present.

In the early embryo the primitive hind gut is separated from the proctodeum by the anal plate. At about the fifth or sixth week an opening becomes established. The orifice is not developed as a circular stoma but as an invagination of irregular interdigitating epithelial-like folds. These folds are the anlagen of the anal papillae and valves of Morgagni.

During the normal course of development this invaginating process takes place in a cephalad direction so that the papillae and valves become situated within the anal canal. Occasionally, however, the embryologic mechanism becomes disturbed so that one or more of these papillae develop in a reverse or caudad direction. The anomalous papillae thus become exteriorized and appear as small, rounded, firm projections at the anal orifice. Usually they are polypoid in shape but they may at times assume a transverse cylindrical form. It may also happen that in addition to the papillary

The anomalous exteriorized papillae at first produce no symptoms. Owing to trauma caused by defecation ulceration tends to develop at the base of the protrusion and causes pain when the bowels move. Discomfort is increased if fibrosis has narrowed the anal orifice.

The clinical history follows a typical pattern. In early infancy the mother notices a small, fleshy tab in or near the anus. Often the baby cries during defecation and a drop of blood may appear on the stool.

Of the eight cases observed five were males and three females. One child was eight years old. The others were infants in the first few months of life. Two patients also had congenital fibrotic bands located at the posterior commissure. Ulceration at the base of an anomalous papilla was present in five cases.

The treatment for this malformation is essentially surgical. The child is given a general anesthetic, usually open cone ether. It is then placed crosswise on the operating table and a nurse or attendant holds the feet back so as to place the infant in a lithotomy position. The field is prepared by washing with alcohol only.

The baby's skin is very sensitive and a dermatitis may be produced by the stronger antiseptics. The anomalous papilla is grasped by a small forceps and a ligature of No. 00 plain catgut is placed above its attachment to the mucosa. The papilla is dissected free, the incisions being carried to the external skin for drainage. The rent in the mucosa is then sutured with fine catgut but the skin wound is left open. If a congenital fibrous band is present, this also is incised. A pressure dressing is strapped in place with adhesive.

The postoperative management is simple. The child is given its usual formula or diet. The wounds are washed with boric acid solution after defecation and a piece of gauze saturated with vaseline is placed under the diaper.

While the operation may be performed on patients of any age, it is advisable to wait until the child is at least four months old if possible. All of the patients in our series made good surgical recoveries and required only two or three days of hospitalization.

What the prognosis would be if the condition is left untreated I do not know. However, it is not uncommon to meet adult patients who date rectal symptoms back to childhood. Often

these persons have anal tags and prolapsing papillae which may have originated as an anomaly similar to that which I have described. That this end result may take place is suggested by one case in our series. The mother of this patient had observed the presence of two anal tabs at infancy but delayed operation until the child was eight years of age. On examination then one papilla about 1 cm. in length was noted which protruded at the right posterior quadrant. There was also an anal tag at the anterior commissure above which was a small, rounded ulcer. Obviously the condition had not corrected itself spontaneously and untreated would probably have persisted to adult life.

#### CONCLUSIONS

1. Anomalous development of one or more anal papillae may occur.
2. This condition manifests itself by exteriorization of the malformed papilla.
3. Ulceration may take place at the base of the papilla and produce symptoms.
4. Excision of the abnormal papillae is indicated.



# RECTAL CALCULUS OF UNUSUAL SIZE

GEORGE L. BECKER, M.D.

*Paterson, New Jersey*

**F**OREIGN bodies formed within the intestinal tract are comparatively rare. They are usually single and small but they may become enormous (23 cm. in circumference).<sup>1</sup> They usually form around a nucleus such as a gallstone, fruit stone, hardened vegetable matter or fecaliths. They are known as enteroliths or coproliths according to whether they are formed in the large or small bowel.<sup>2</sup>

Chemical stones result from the prolonged ingestion of mineral drugs used for indigestion such as bicarbonate of soda, bismuth, salol, calcium and magnesium carbonate and other such drugs.

Predisposing factors are a sluggish intestinal tract, constipation, defective innervation of the bowel wall or a weakness of the intestinal musculature and a sedentary life.

## CASE REPORT

A woman, seventy-seven years of age, with complaints of rectal pain associated with prolapsed hemorrhoids, diarrhea, and rectal incontinence was seen. One week previous to this attack of rectal pain the patient had suffered from gastroenteritis lasting two days with severe cramps and profuse diarrhea. After the cramps and diarrhea had subsided it was observed that a lump which was always present in the right side of the abdomen had disappeared.

The patient's past history included a gallbladder operation in 1907, hypertension since 1923 and a cerebral accident in 1925 which resulted in complete permanent right sided spastic paralysis. At the time of the cerebral accident it was discovered that the patient had diabetes. She had been suffering for many years from indigestion, gas and dizzy spells with attacks of diarrhea for which she took bicarbonate of soda and epareal antacid tablets which produced very little relief of the digestive symptoms.

Examination revealed a distended urinary bladder. One thousand cc. of urine were removed by catheterization following which the urinary output was normal for two days. Then the bladder became distended and the patient was unable to void. Catheterization revealed that the urinary bladder was full of bloody urine containing many clots. Tidal drainage of the urinary bladder was started. It was necessary to irrigate the catheter

with a syringe every hour to remove the blood clots which interfered with the normal function of the tidal drain. Rectal examination revealed a corona of prolapsed edematous internal hemorrhoids. Digital examination revealed a hard irregular mass with many sharp spurs about the size of a tennis ball. The mass was movable within a dilated voluminous rectum which bled easily. A satisfactory sigmoidoscopy was not possible.

Laboratory findings were: urinalysis, acid reaction; specific gravity, 1.010; albumin, two plus; sugar, slight trace; acetone, negative; indican, negative; microscopic examination, masses of pus cells, red blood cells and epithelial cells. Blood chemistry: urea nitrogen, 18 mg. per 100 cc. of blood; uric acid, 1.7 mg. per 100 cc. of blood; creatinin, 1.1 mg. per 100 cc. of blood; sugar, 296 mg. per 100 cc. of blood; chlorides, 480 mg. per 100 cc. of blood; non-protein nitrogen, 37 mg. per 100 cc. of blood; calcium, 14.65 mg. per 100 cc. of blood; alkaline phosphates, 5.3 Babinsky units. The blood pressure was systolic 230, diastolic 130.

Roentgenogram of the abdomen (scout film) revealed a marked distention of the jejunum, ileum, ascending and transverse colon and a marked distention of the descending and sigmoid portion. A calculus, irregular in contour and approximately  $7\frac{1}{2}$  by  $8\frac{1}{2}$  cm. occupied the rectum. The calculus had a central nucleus appearing to be more densely calcified. There was noticeable calcification within the walls of the abdominal aorta. (Figs. 1 and 2.)

Under low spinal anesthesia a posterior proctotomy was performed in order to reach the stone which had gravitated up to the rectosigmoid junction just beyond reach of a hand placed in the vagina. The stone was grasped by one of its spur-like projections and a pair of sponge forceps was used to draw it down within reach of the hand in the vagina. An attempt was made to crush the stone but it was too dense and hard. All the usual grasping forceps available were too small to grasp the stone. It was necessary, therefore, to apply a pair of low pelvic obstetrical forceps to deliver the stone through the anal outlet. The posterior proctotomy had to be enlarged sufficiently to allow forcible extraction. The proctotomy divided the entire internal and external sphincter muscle as well as the puborectal fibers of the levator. The cut muscle fibers were united with interrupted sutures of chromic catgut. Oxycel dressings were applied. The flat blades of the obstetrical forceps encased most of the sharp spurs which would have caused



FIG. 1. Illustration shows distention of large and small intestines; irregular calculus is within the rectum.

considerable laceration of the mucosa. Recovery was uneventful.

The patient was discharged from the hospital fifteen days postoperatively. She had good control of her bowels and developed several soft fecal impactions. All the previous symptoms, gas, indigestion, dizzy spells, abdominal pain and diarrhea disappeared; her blood pressure was 190 systolic and 110 diastolic. The patient recovered sufficiently to be allowed out-of-doors each day and was able to enjoy automobile rides.

The gross pathologic specimen consisted of a hard, round, black, calcareous structure, 6 cm. in diameter and 23 cm. in circumference the surface of which was studded with projections of the same material, some reaching a length of 1 cm. The mass weighed 125 Gm. Pathologic diagnosis was intestinal stone.

#### COMMENTS

The stone originated in the cecum around a gallstone nucleus; its unusual size is probably



FIG. 2. Photograph of calculus, measuring 23 cm. in circumference, showing unusual formation with many irregular-shaped projections.

accounted for by the prolonged habitual use of alkaline medication. As shown by the x-ray (scout film of the abdomen) the enormous size of the stone caused an obstruction of the terminal portion of the colon. Reflexly the obstruction was the cause of indigestion, gas and abdominal pain. Acute urinary retention and hematuria were caused by the pressure of the stone on the urinary bladder.

Small low pelvic obstetrical forceps were a valuable aid in recovery of the foreign body. Its blades were easy to apply and adjust. The stone was firmly grasped and most of its sharp projections were covered by the blades, thus protecting the rectal mucosa from undue trauma while the stone was extracted by traction through a posterior proctotomy.

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# Papers Read by Title

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## CHRONIC BURROWING ULCERATION OF THE PERINEUM DUE TO MICRO-AEROPHILIC HEMOLYTIC STREPTOCOCCUS\*

JOHN CHELEDEN, M.D.  
*Philadelphia, Pennsylvania*

CHRONIC, undermining, burrowing ulceration due to micro-aerophilic hemolytic streptococcus is now accepted as a clinical entity. Its mode of onset is understood, its bacterial etiology has been confirmed repeatedly and the characteristic appearance of the disease process after it has become established should be recognizable. The favorable influence of properly employed zinc peroxide on the course of the infection has been demonstrated.

Meleney in 1935 was the first to give a comprehensive report of this condition. Fortunately this type of chronic progressive ulceration of the skin is rare, but it is important because of the extent of its involvement of the body surfaces, its stubborn resistance to the usual forms of treatment and frequently fatal outcome.

The disease process may attack any part of the body and any person, regardless of age, sex or color. It usually occurs following incision of infected lymph nodes, in postoperative wounds, as contamination of traumatic wounds or a previously existing infection. The ulceration begins gradually in what appears to be an ordinary drainage tract from an abscess which may be superficial or deep. The skin margin becomes undermined by liquefaction of the subcutaneous fat and connective tissues. The skin edges become blue, but not gangrenous, and roll in. In other smaller areas the surrounding skin thins out, ulcerates and fuses with the original or mother ulcer. Ulceration and sinus formation vary depending upon the situation of the area of skin involvement. In the perineum where the skin is thick and resistant to necrosis, burrowing is greater, sinuses are more numerous

and ulceration is limited. Muscle and bone are not often affected. Fever, pain and severe prostration are present in only a few cases. The etiologic agent is the micro-aerophilic hemolytic streptococcus, an organism which lies intermediately between the aerobic and anaerobic groups, preferring a reduced oxygen environment for further multiplication. Their immediate source is probably the intestinal tract or vagina. In many cases the organism can be obtained only by anaerobic cultivation and is therefore missed frequently when routine aerobic methods of culture are employed.

Treatment with ordinary antiseptics usually produces no permanent effect. The ulcer continues as an ordinary infection for a time and may show considerable improvement following any treatment. Ultimately, however, improvement ceases. The infectious process may remain stationary or become more extensive, never healing completely.

When properly applied, zinc peroxide controls the spread of infection. Under its influence the streptococci lose their anaerobic and later their hemolytic properties. The wounds heal and behave in much the same way as wounds infected by ordinary hemolytic streptococcus. The development of this therapeutic agent, its mode of preparation and technic of application are described best in early reports of Meleney and his co-workers.

There are three criteria for success in the use of zinc peroxide: (1) The chemical agent must be potent. (2) The freshly prepared creamy suspension in water must be in intimate contact with all parts of the infected surface. (3) The

\* From the Jefferson Medical College Hospital, Department of Proctology, Division of Surgical A Service, Philadelphia, Pa.



FIG. 1. Case 1. Photograph of artist's drawing of spreading multiple ulcers of the perineum due to micro-aerophilic hemolytic streptococci three weeks after onset of disease.

dressing must be effectively protected against evaporation and drying.

Sulfanilamide administered by mouth has proved helpful in many cases. In a number of instances penicillin has been employed. Immediately following the first report of treatment with this antibiotic its use was thought to possess no value. Recent reports indicate that it has a beneficial effect when employed both parenterally and locally.

It is the purpose of this paper to report five cases which showed the typical clinical characteristics of chronic, undermining, burrowing ulceration due to micro-aerophilic hemolytic streptococci in which the patients were observed and treated on the proctologic service of The Jefferson Medical College Hospital and to re-affirm the favorable influence of zinc peroxide on the course of the infection. In addition, certain features in the diagnosis and management of this unusual condition as it pertains to proctology will be stressed.

A sixth case is included which exhibited all the clinical characteristics of this type of surgical infection and in which the patient improved following the use of zinc peroxide therapy. However, the anaerobic organism was never identified.

December, 1948



FIG. 2. Case 11. Perineal ulceration seven years after onset of disease. Photograph taken at time of last admission. Note the undermined, rolled in skin edges, burrowing sinuses, with large daughter ulcers.

#### CASE REPORTS

**CASE 1.** T. A., a colored female aged thirty-eight years, was admitted December 28, 1939, for study because of remittent fever, the etiology of which was unknown. After extensive studies a diagnosis of trichiniasis was made. On February 1, 1940, a small swelling developed over the posterior perianal area. This was painful and tender and after several days a superficial abscess developed which was allowed to rupture spontaneously. Several days later a similar abscess formed approximately 1 inch from the first lesion and closer to the anal opening. It was thought that an anal fistula had developed but examination failed to reveal any connection with the anal canal. A third area of ulceration developed over the sacral region. Routine treatment extending over a period of twelve days was ineffectual; in fact, the ulceration appeared to spread. (Fig. 1.) Anaerobic cultures were requested and the micro-aerophilic hemolytic streptococcus was found. A suspension of medicinal zinc peroxide in water was applied and what previously appeared to be chronic ulcerating, sluggish wounds now began to heal.

On March 1st there was a change of interns and because of this fact saline compresses were ordered to replace the zinc peroxide dressing. The ulceration then began to extend even further than when the patient was first seen. Three weeks later zinc peroxide therapy was resumed. The wound assumed its previous healthy appearance and healing was complete April 15, 1940. The patient was discharged April 30, 1940, and was seen six months

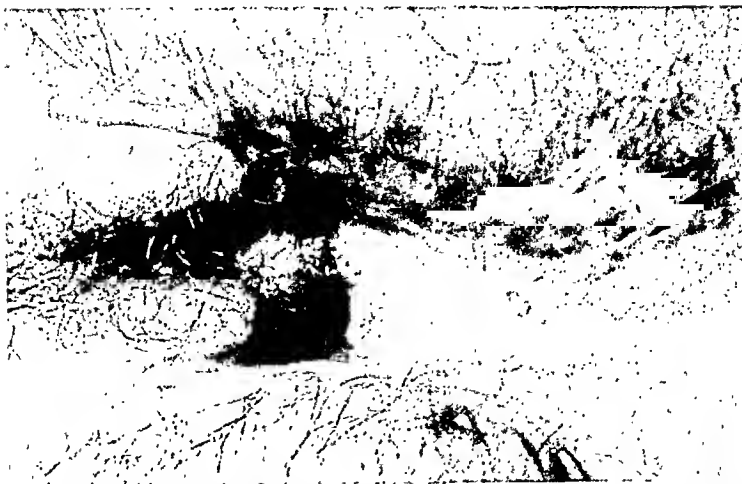


FIG. 3. Case 11. Ulceration completely healed; same patient as in Figure 2.

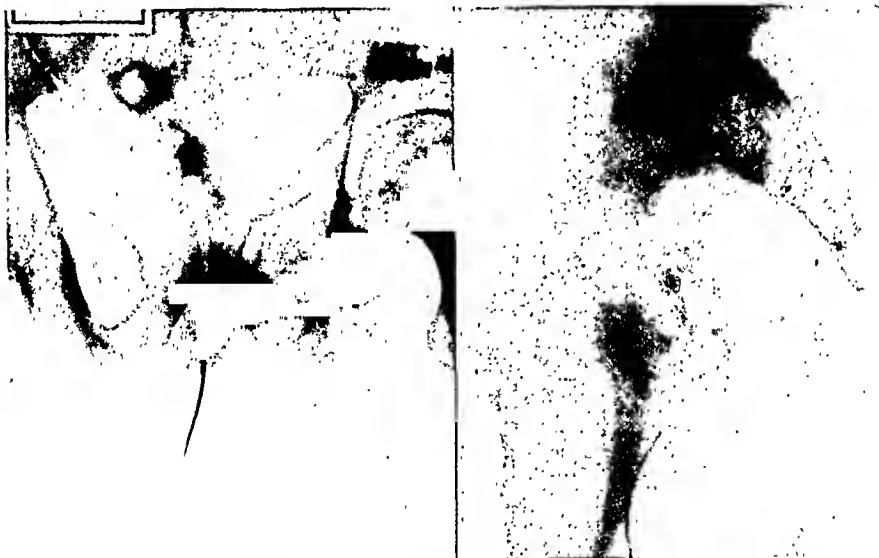


FIG. 4. Case 111. Roentgenogram following injection of radio-opaque medium into perirectal fistulous tract, showing penetration of tract into depth of pelvis.

later. Ulceration had not recurred during this period.

*Comment.* This case shows the ill effects of interrupting treatment too early.

**CASE 11.** T. B., a white male aged twenty-five years, was first admitted on August 1, 1933, and at that time a diagnosis of perianal abscess and anal fistula was made. The patient was admitted to the hospital eight times during the period from August 1, 1933, to June 2, 1940, and an operation was performed each time. It was believed that the entire fistula had been excised at the time of the initial surgical procedure. The patient was then referred to the out-patient department for post-operative care. When it seemed that the wound had healed completely, swelling occurred at variable distances from the site of the original perianal

abscess and another sinus developed. During each of the eight successive admissions to the hospital thorough debridement was performed. Following each operation, complications developed which were similar to those which followed the first admission.

Repeated studies were made to exclude actinomycosis, tuberculosis, syphilis, lymphogranuloma venereum and granuloma inguinale. Every conceivable antiseptic was used upon the chronic ulcerating areas without any beneficial effect. At times the perianal sinuses would appear to be almost completely healed, but soon they would break down, become undermined further as well as more extensive. (Fig. 2.)

On June 2, 1940, the last admission, cultures were made of the discharge from a deep perianal sinus and a pure growth of microaerophilic hemolytic streptococci was obtained. The sinuses

were then opened widely, as had been done on previous occasions, and zinc peroxide paste was applied twice daily. In the course of three weeks the wound had healed completely. There was no evidence of recurrence during the ensuing year. (Fig. 3.)

*Comment.* This case exemplifies the following factors: (1) routine cultures possessed little value; (2) loss of time for the patient was a serious problem (over one hundred days in the hospital); (3) wasted effort of the physician.

CASE III. J. W., a white male aged forty-six years, was admitted March 14, 1939, with a diagnosis of extensive anal fistula of ten years' duration.

The patient had been operated upon in 1929 for an ischorectal abscess and anal fistula. The wound failed to heal. A second operation was suggested by the attending physician but the patient refused. During the next ten years it was necessary for the patient to wear a dressing continuously because of profuse drainage from the perianal wound.



FIG. 5. Case III. Photograph of artist's drawing made following surgical exploration and excision of multiple fistulous tracts of the perineum and perirectal spaces. Micro-aerophilic hemolytic streptococci together with *Bacillus Welchii* were found in culture from this wound



FIG. 6. Case III. Showing complete healing of all perianal ulcerating areas twelve years after onset.

When the patient presented himself on March 14, 1939, nine external openings were found in the tissues adjacent to the anus. These sinuses communicated with each other and with three internal openings, one of which was in the anterior anal canal and another was approximately 2 inches above the anus and situated posteriorly. Studies were made in order to exclude actinomycosis, syphilis, lymphogranuloma venereum and granuloma inguinale. X-ray examination performed after a radio-opaque solution had been injected into the sinuses failed to reveal any connection between the sinuses and the bony structures. The presence of an

intermittent fever was disclosed during the pre-operative period.

On March 28, 1939, the fistulas were explored surgically. The great extent of the fistulas as indicated by x-ray studies (Fig. 4) was confirmed. Appropriate drainage was provided and after that the wound appeared to be healing satisfactorily except for the extension of ulceration and undermining in the anterior perianal area. (Fig. 5.) On May 2, 1939, the wounds were débrided again because of additional sinus formation and also to provide better drainage. At this time it was noted that the granulation tissues in the deep portion of



FIG. 7. Case iv. Perianal ulceration in a patient with ulcerative colitis three years after onset showing undermining. The base is composed of grayish, shaggy, gelatinous granulations.

FIG. 8. Case iv. Showing almost complete healing of the perianal ulceration; photograph taken one month after Figure 7.

the wounds appeared to be gray and shaggy. Fever rose to 103°F. and continued daily and the patient failed rapidly. Peritonoscopy was performed in order to determine if there was a communication with the peritoneal cavity. None was found. At this time it was noted that the liver was firm, somewhat shrunken and slate-gray in color. Amyloid disease was suspected but was not confirmed. On August 3, 1939, the patient was discharged with a poor prognosis. The weight loss was 23 pounds during the four-month period of hospitalization. Dressings were continued in the out-patient department

biweekly. Various antiseptics were used without beneficial effect. Weakness and fever continued.

On August 19, 1940, cultures were made from the discharge of the fistulous tracts and the perianal ulceration. Aerobic and anaerobic microaerophilic hemolytic streptococci were found. In addition, *Bacillus Welchii* were discovered. Zinc peroxide paste was then used and immediate improvement was seen, especially in the healing of the perianal sinuses. Difficulty was encountered in reaching the depths of the extensive wound. When the zinc peroxide was introduced it would dry quickly and cause pain. Sulfanilamide was given by mouth and a saturated solution of this agent was placed into the deeper portions of the wound. Applications of zinc peroxide were continued over the more superficial areas. The granulation tissue assumed a healthy appearance, the discharge decreased, the fever subsided and the patient gained weight rapidly. On December 5, 1940, the right side had healed and the depth of the cavity on the left side had decreased from approximately 5 or 6 inches to 2 inches. Cultures from the unhealed portion of the wound did not show either streptococci or *B. Welchii*. Zinc peroxide was discontinued in January, 1941, five and one-half months after its first application and at that time all the ulcerated areas had healed. (Fig. 6.)

*Comment.* (1) This case proves the extreme toxicity which accompanies this type of surgical infection; (2) without proper management it might have progressed to fatal outcome; (3) it serves to illustrate the difficulty experienced when treating deep cavities; (4) sulfanilamide employed locally and systemically was beneficial.

**CASE IV.** F. G., a white male aged twenty-five years, was admitted April 14, 1939, with a diagnosis of ulcerative colitis and multiple anal fistula of two years' duration. Extensive ulceration of the rectum and the lower portion of the sigmoid was present at the time of admission. A superficial anal fistula was situated posteriorly and there were several perianal sinuses. On April 28th the fistula and sinuses were excised. Attention was then directed toward treatment of the ulcerative colitis and the patient improved sufficiently to be discharged on September 15, 1939. Dressings of the perianal wounds were continued in the out-patient department.

On March 2, 1940, the patient was readmitted because of the development of additional perianal sinuses, with undermining of the old wounds. (Fig. 7.) These were opened widely, and again the patient received care in the out-patient department. Healing appeared to progress normally for several weeks, but after that the condition of the wound

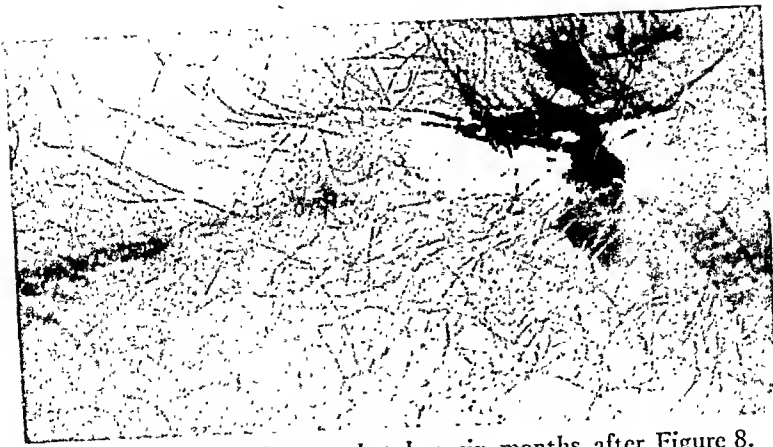
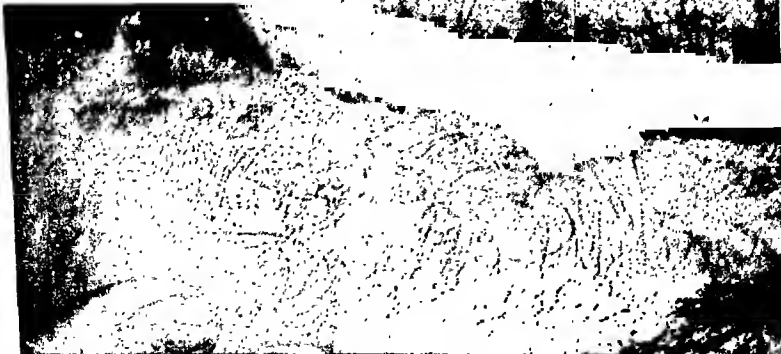


FIG. 9. Case iv. Photograph taken six months after Figure 8.



10



11

FIG. 10. Case v. Spreading perianal ulceration in a tuberculous ulcer from which anaerobic hemolytic streptococci were recovered. Note presence of daughter ulcer.

FIG. 11. Case v. One month following application of zinc peroxide. There is a definite attempt at healing. The daughter ulcer has healed completely; undermining is still present, however.

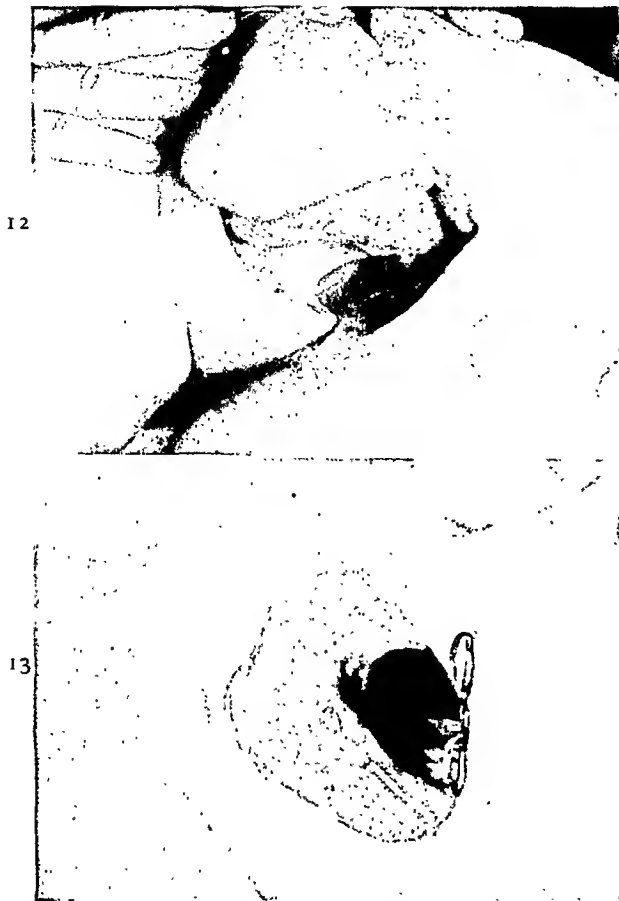


FIG. 12. Case v. Four and one-half years after onset of disease showing extensive ulceration of left perianal area and buttock beginning with development of abscess. Note rolled in skin edges and extensive burrowing.

FIG. 13. Case vi. Same patient as in Figure 12, showing extensive ulceration and cavitation over left iliac fossa. Note thinning and rolling of skin edges with bluish discoloration. A daughter ulcer is in process of formation. The proximal end of a Kelly hemostat protrudes from the depth of the ulcer.

did not improve. On June 5, 1940, cultures were made from the discharge of the sinuses and microaerophilic hemolytic streptococci were found. Dressings of zinc peroxide paste were started but little improvement was noted. On July 24, 1940, cultures were made from the bowel wall and studies for anaerobic organisms were requested. Microaerophilic hemolytic streptococci were found in this culture. Sulfanilamide was given by mouth. In addition a saturated solution of sulfanilamide was instilled into the rectum twice daily. Dressings containing zinc peroxide paste were continued. Following this, the perianal wounds and the appearance of the mucosa of the bowel improved steadily. (Fig. 8.) During the period of six months from December, 1940 to June, 1941 there was no recurrence of ulceration. (Fig. 9.)

CASE V. H. C., a white male aged fifty years, was admitted June 14, 1940, with a diagnosis of anal fistula. Prior to admission two fistulectomies, performed during a period of fourteen months, appeared to be unsuccessful.

Examination revealed an irregularly shaped ulcer which involved the posterior portion of the anal canal and extended into the perianal skin for a distance of  $2\frac{1}{2}$  inches. In addition, superficial chronic sinuses were present in the anterior portion of the anal canal.

A biopsy of the ulcerating area showed definite tubercle formation. Lactic acid bacilli were recovered from cultures made routinely. Anaerobic cultures were requested and facultative anaerobic and aerobic gram-negative rods and hemolytic streptococci were found. A diagnosis of chronic bilateral fibro-exudative pulmonary tuberculosis was made following x-ray study of the chest.

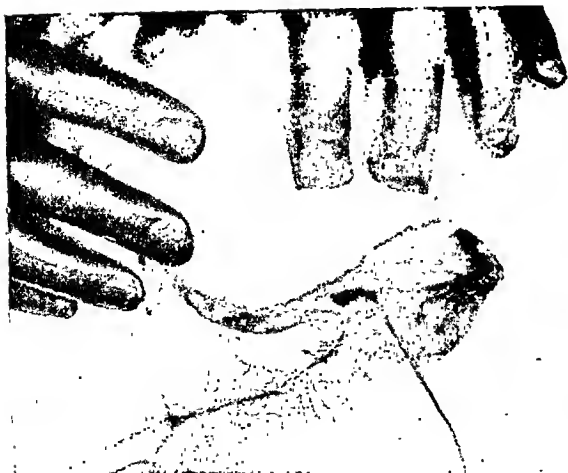
On June 22, 1940, the ulcers were fulgurated. For several weeks afterwards the wound appeared to heal satisfactorily, and the patient was discharged with instructions to return to the out-patient department for dressings. Improvement was slow but steady for approximately eight months, but the ulcer never healed entirely. Once more the ulcer began to extend and the skin edges became undermined and rolled in. The base was yellow and contained grayish granulations and several daughter ulcers had developed in the adjacent areas. (Fig. 10.) The patient was readmitted to the hospital on March 7, 1941. Anaerobic cultures were made and the presence of anaerobic and aerobic bacilli coli communis, and streptococci non-hemolyticus was confirmed. Dressings containing zinc peroxide paste were applied to the ulcerating areas and they improved perceptibly. (Fig. 11.) The patient was sent to the out-patient department where he received dressings daily. Two months after the first application of zinc peroxide the ulcers were healed. The patient was then admitted to a tuberculosis sanatorium for treatment of pulmonary tuberculosis.

*Comment.* This is an example of the spread of a tuberculous ulcer which had been contaminated by anaerobic organisms.

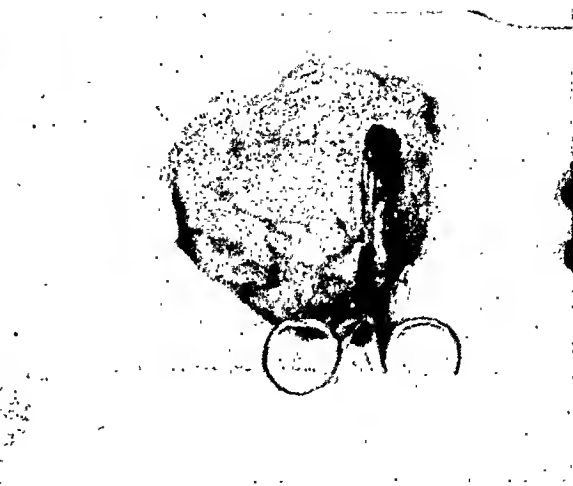
CASE VI. L. L., a white female aged sixty-four years, was admitted October 30, 1947, with a diagnosis of chronic ulceration of the left perianal and left iliac areas.

Four and one-half years before admission an abscess developed on the left side of the anus. It was incised and drained and treated as an anal fistula. The wound failed to heal with routine treatment; in fact, it became more extensive. On March 12, 1945, a laparotomy was performed and a search was made for a fistulous opening high in the





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15

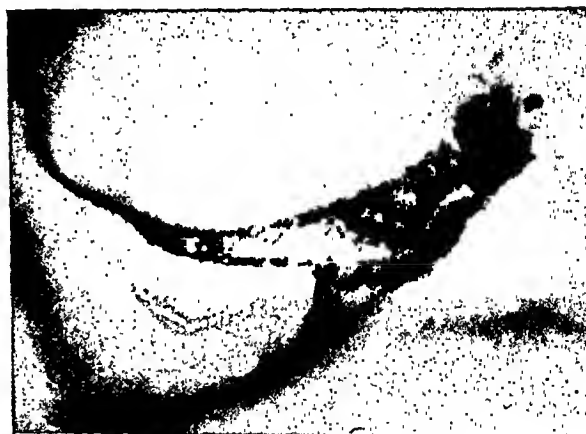
FIGS. 14 and 15. Case vi. Photographs taken four months after Figures 12 and 13, respectively.

rectum. None was found, but a colostomy was made to prevent contamination of the perianal wound by fecal material. The patient developed a deep abscess in the left iliac area. Subsequently, extensive ulceration similar to that which was present in the left perianal area involved the left lower abdominal wall.

The patient was a fairly well nourished, elderly female who obviously was suffering from pain. An extensive, deep ulcerating wound was present over the left perianal area and the buttocks on that side. (Fig. 12.) Another deep cavity was present in the left iliac area. A large fistulous opening extended into the distal loop of the sigmoidal portion of the colon where the ulcerating process had eroded. The surrounding skin was undermined and thinned out, the edges rolled in and there was bluish discoloration in some areas. (Fig. 13). Repeated studies were made for actinomycosis, syphilis, tuberculosis, lymphogranuloma venereum and granuloma inguinale, with negative results. Repeated study of the discharge showed staphylococcus, colon bacillus and occasional streptococcus hemolyticus. Anaerobic organisms were never found. The patient complained of severe pain, and the temperature rose to 102°F. There was moderate anemia; the blood chemistry findings were normal.

Repeated transfusions were administered. Zinc peroxide paste was packed into the deep cavities twice daily, and beginning November 11, 1947, penicillin was given in doses of 100,000 units every three hours. The ulcerating cavities gradually assumed a healthy appearance and there was a tendency to fill in. The patient was discharged two months later somewhat improved.

Applications of zinc peroxide paste were continued at home by the referring physician and the patient's husband. The patient was readmitted two and one-half months later for follow-up examination. There was marked general improvement; she had gained 6 pounds in weight and the fever had



16



17

FIGS. 16 and 17. Case vi. Photographs taken ten months after Figures 12 and 13, respectively, showing the slow but progressive improvement.

subsided. The large ulcerated areas had filled in to a great degree. (Figs. 14 and 15.) The fecal fistula, with internal opening into the sigmoid colon, had closed spontaneously. Treatment with zinc peroxide paste was continued at home. The patient was seen again six and ten months after the initial application of specific therapy. General improvement was noticeable with a weight gain of 35

December, 1948



pounds. The improvement in the appearance of the ulcerated areas was considerable. (Figs. 16 and 17.)

#### SUMMARY AND CONCLUSION

Five case abstracts are presented which afford typical illustrations of chronic, undermining, burrowing ulceration caused by micro-aerophilic hemolytic streptococcus. Although the sixth patient exhibited all the clinical characteristics of the disease, including improvement following use of zinc peroxide therapy, the micro-aerophilic hemolytic streptococcus was never isolated despite repeated attempts.

The proximity of these wounds to the intestinal tract was evidently a contributory factor in the development of this type of infection.

It is surprising that in only one instance was the disease suspected early in its course. After many forms of treatment had failed actinomycosis, syphilis, tuberculosis, lymphogranuloma venereum and granuloma inguinale were usually suspected.

The fifth case illustrates the spread of ulceration of a recognized tuberculous ulcer due to contamination by secondary anaerobic organisms.

The importance of early diagnosis, recognition of the clinical manifestations and isolation of the causative organisms by securing anaerobic as well as aerobic cultures is stressed.

The efficacy of properly employed zinc peroxide therapy, as observed by Meleney, is confirmed. Strict adherence to all the details in the application of zinc peroxide paste and continuance of this treatment until healing is complete is necessary if success is to be accomplished.

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# PRURITUS ANI

## A STUDY OF RESULTS WITH GENTIAN VIOLET IN 210 CASES

JAMES T. JENKINS, M.D.

Peoria, Illinois

**G**ENTIAN violet was first used in the United States by Faust in 1930 as an anthelmintic. It was the first effective drug therapy against *Strongyloides stercoralis*. Later the dye was found to be the most effective anthelmintic for treatment of oxyuris vermicularis.

The antiseptic dyes have a marked specificity of action which seemingly is related to the staining properties of bacteria. The staining properties in turn are dependent upon physico-chemical characteristics of the constituents of the bacterial cells. Therefore, it is believed that the bactericidal action of the antiseptic dyes is closely related to the physicochemical properties of the compounds. Antiseptic dyes can be divided into two groups depending upon whether the color-producing radical is electropositive or electronegative. The electropositive dyes have a special affinity for gram-positive organisms, are more effective in a basic medium and are called the basic dyes. This does not mean that the compounds themselves are basic but rather they have an affinity for chemically basic groups. The acid dyes are active against gram-negative organisms and act best in an acid medium. Other factors than type of organism and pH also influence the activity of germicidal dyes. Their antiseptic properties are greatly diminished in the presence of serum or other organic material. Temperatures higher than that of the body also decrease their effectiveness.

All the antiseptic dyes are toxic to tissue cells as well as to micro-organisms. In the case of some compounds the sensitivity of host cells is greater than that of the parasite. However, many of the dyes have a high therapeutic index and several are effective even after intravenous administration.

The triphenylmethane or rosaniline dyes are a group of basic dyes which are effective germicides against gram-positive organisms. The group includes gentian violet, crystal violet, methyl violet, brilliant green and acid and basic fuchsin. The first four are used medicinally. The rosaniline dyes are bactericidal to

gram-positive micro-organisms in dilutions of approximately 1:1,000,000. They are particularly effective against staphylococci, *B. diphtheriae* and *B. pyocyaneus*. Also the causative organism of Vincent's angina and many strains of monilia (fungus), torula (yeasts), epidermophyton and trichophyton are susceptible to this group of dyes. Gentian violet is also an effective anthelmintic. The gram-negative bacteria are very resistant to the rosaniline dyes.

### PRURITUS ANI—A SYMPTOM OR A DISEASE

From the literature it seems agreed that from 60 per cent more or less of the cases of pruritus ani have a dermatologic condition caused by fungi and/or a secondary infection. An anorectal disorder is an exciting cause; crypts, anal glands, ulcers, fistulas and vaginal discharges are predisposing causes, preparing the skin for the invasion and the secondary changes such as edematous thickening of the skin, vesicles, excoriation, maceration, radial fissuring, fibrosis, etc.

Any existing condition responsible for perianal moisture may prepare the field for secondary invasion. On the contrary, there are numerous patients with prolapsed internal and external hemorrhoids with continuous moisture and no pruritus ani. One patient was seen with complete prolapse of the rectum and no pruritus ani. Itching associated with or initiated by a bowel movement is frequently caused by a fissure or anal ulcer, deep crypt or prolapsing hypertrophied papillae.

After reviewing the voluminous literature which lists as exciting causes all parts of the body from the scalp to the feet and only twice referring to the colon as a site for the exciting cause, we believed there might be something here which has not received deserving consideration.

We found the most common invader of the intestinal tract in man to be the oxyuris vermicularis. Leuchart in 1876 said, "There may be only a few who do not harbor oxyuris vermicularis at one time or another." The United States Medical Corps in 1944 in a

survey of 2,900 white adults and children found that 41 per cent gave positive tests. Sick of Michigan reports 20 per cent or more were found to harbor this infection. Miller of Gorges Hospital in the Canal Zone, in 1944, reported that in 20 per cent of thirty-five appendectomies, the appendix contained pinworms. He also reported that members of the white race were more susceptible than the colored. Peterson at Minnesota State Hospital in 1942 reported that 59 per cent of 1,871 patients gave positive tests.

Lane in *The Lancet* in 1944 reported no experimental animal is known in which oxyuris vermicularis will develop. The life of this parasite in guinea pigs, mice, cats, dogs or monkeys has been unknown even after attempts to lessen the resistance of the hosts. The horse, I understand, is subject to infestation and life of the oxyuris.

The life of pinworms is spent usually in the ileum and the cecum. The translucent female parasite about to give birth to young reaches the rectum at certain hours, usually at night, passes out through the anus, travels to the perianal skin and clothing and deposits from 10,000 to 20,000 eggs, after which she becomes opaque and dies. The male dies in the right colon after fertilization of the female. Few eggs survive forty-eight hours and none survives ninety-six.

There is a gap in the life history. It covers the period from the time at which the egg either reaches the nose (from which Lentze, in 1935, recovered it) or is more directly swallowed, and that at which the worm reaches the rectum. Since the female threadworm rarely oviposits before leaving the bowel, microscopic examination of the stool for eggs cannot determine their presence. So Hall devised the N.I.H. swab, cellophane tape, glass rods, etc., which may reveal the presence of eggs in the uncleaned and untreated individual. Brown reports that six weeks after ingestion of the ova the gravid female migrates out of the anal canal. Leuchart reports eggs swallowed are mature worms in from fifteen to twenty-eight days.

Cram in *Medical Annals of the District of Columbia* writes that of all the helminths which parasitize man, the pinworm is more intimately associated with man throughout its life history than is any other species. The pinworm is the only intestinal parasite not requiring an intermediate host. Consequently, we

may consider as unique the manner in which the eggs of the pinworm are disseminated and infection acquired. The migration of the pinworm through the anus, the deposition of its eggs on the skin in the perianal region and in the vagina of females, the development of its eggs to infectivity within six hours under the conditions of temperature and humidity which are present in these regions are factors that facilitate re-infection of an individual.

The sensitivity of man to pinworms varies greatly. Some individuals get a terrific reaction varying from nausea and vomiting, abdominal pains and cramps, diarrhea with mucus and blood with marked perianal inflammation, to no evidence at all except pruritus ani. Some have mild abdominal symptoms and no pruritus ani while others have no symptoms at all but may discover a worm. One male patient, aged forty-two, stated that he had seen worms with each bowel movement since childhood.

In this study made in the past two years of over 200 patients whose chief complaint was pruritus ani, 70 per cent of them stated that itching occurred only after retiring at night or was greatly aggravated at that time. Our practice for the past six years to apply a 3 per cent gentian violet paste to the anal canal and perianal areas following the anorectal examination was routine; hence, we were surprised to find invariably from patients with pruritus ani that they were able to sleep undisturbed for the three succeeding nights following the examination, after which time some pruritus returned and the patient returned requesting more of the same treatment. Our interest was greatly aroused as to the reason for this marked relief from itching, as usually the perianal area would show considerable improvement. Since this study was begun two years ago, we have actually found worms in only ten of more than 200 patients, all of whom have had anoscopic, proctoscopic and sigmoidoscopic examinations. All female patients have had pelvic examinations including bimanual and catheterized specimens of urine. No stool examinations were made and few attempts to find the ova were made as these were all unsuccessful except one in which a female worm was found depositing her eggs. This was a male child aged fifteen months.

#### TREATMENT

In the past two years, all patients with pruritus ani are placed on the same regimen,

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with the objective being to eliminate the pruritus before any other procedure is instituted regardless of the condition. All patients are seen twice weekly at which time the perianal area is painted with a generous amount of gentian violet compound. This preparation contains gentian violet 3 per cent, tannic acid 10 per cent and 1 per cent pontocaine. This medication is to be left on until the morning bowel movement after which the area is to be washed with cotton and water and then dried. A thin application of an ointment containing one part of salicylic acid to two parts of benzoic acid in petrolatum is applied to the perianal area. Before retiring the area is again washed with cotton and water, then dried and the ointment applied. A thin layer of cotton separates the buttocks.

Orally, the individual is given enteric coated tablets of gentian violet three times daily before meals, the dosage varying from  $\frac{3}{2}$  gr. to 1 gr. This is to be continued for eight days followed by an eight-day rest and a repetition of the eight-day oral intake of gentian violet tablets. Cleanliness must be continued and no soap is used. Constipation, when it existed, was corrected by the use of bulk, sufficient fluid intake for normal body chemistry and large doses of vitamin B compules with C, when bulk and fluids were not sufficient to correct this bad habit. Mineral oil was never used and those patients using mineral oil were changed to the bulk, thereby making cleansing of the perianal area much easier.

In every case except six of the 210 included in this study, the itching was eliminated at night and sleep was undisturbed. Two of these six cases were secondary syphilitic ulcerations and were not affected by the gentian violet therapy, but were cured by specific treatment. The other four were failures and the patients failed to return after the gentian violet therapy.

Of the 210 cases under study 136 were apparently cured from medical management alone. The perianal skin had returned to normal and the patient remained symptom-free. Sixty of the patients had subsequent injection of the internal hemorrhoids and another fifty-one were operated upon for anorectal disturbances after their symptoms had subsided. Seventeen were operated upon as the pruritus persisted intermittently but these people were all bothered with itching only in the daytime.

There were twenty recurrences within three months after discharge as cured. Twelve had

had surgery and eight only medical management. These responded to medical treatment and were discharged after their second round of oral therapy, the early response in the recurrences being due to lack of secondary involvement of anal and perianal skin.

In addition to the previously mentioned hemorrhoids, other forms of disorders encountered included thirteen adenomas, one of which was malignant; eight anal ulcers; seven fissures; seven crypts; seven fistulas; two anal glands; three ulcerative colitis; four condylomas; three trichomonas vaginalis; three vulvovaginitis with perianal excoriation which all cleared up completely. One female who two years previously had had a vulvectomy for pruritus ani and vulvae had a recurrence of the same severity which cleared up completely with gentian violet medication. Six patients had had previous x-ray therapy with recurrence in from three to eight months and were cleared up completely with the gentian violet treatment. Four patients had had clover-leaf or Ball operations elsewhere for pruritus ani with return of the symptoms within three months; gentian violet therapy completely relieved them of all symptoms and there has been no recurrence in the past year in any of them.

#### SUMMARY AND CONCLUSIONS

This study covers too small a group and over too short a period of time for definite conclusions. Gentian violet orally and locally seems to have a definite place in the complete relief of nocturnal symptoms in those not completely cured. The incorporation of additional medicaments may be of value, especially one which is bactericidal to gram-negative bacteria. Other fungicides are unquestionably of value in alleviating the secondary skin invasions.

Gastrointestinal reactions occurred in approximately one-third of all 210 patients taking gentian violet medication. Reactions varied in severity from mild nausea and abdominal discomfort to vomiting with cramps and diarrhea. Reduction of dosage in all cases eliminated reactions and all were able to continue with two courses of the eight-day treatment.

The rôle of intestinal changes, parasites, secondary involvement of the mucosa and sub-mucosa, gram-negative bacteria, anaerobic bacteria and changes in pH, as well as allergic reactions are not thoroughly understood. Further studies would be of value in determin-

ing the etiology and exciting cause of pruritus ani.

The rôle of oxyuris vermicularis and prevalence of the infestation is not fully appreciated. Better methods of detecting their presence are constantly desired. Their eradication by the use of gentian violet has been 100 per cent as far as we were able to determine. The possibility of oxyuris vermicularis as the exciting cause of regional ileitis cannot be completely overlooked.

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# LYMPHOPATHIA STRICTURE OF RECTUM COMPLICATED BY SECONDARY STRICTURE OF ASCENDING COLON OF PROBABLE TUBERCULOUS ORIGIN

W. A. SCHEFFLER, M.D.

*Camden, New Jersey*

IN looking over the literature, the Index Medicus and the report of 476 lymphopathia cases by Louis T. Wright, Freeman and V. Bolden in the Archives of Surgery, November, 1946, covering the years 1930 to 1945, no case of a combined lymphopathia and tuberculous stricture could be located. It seems, therefore, that this unusual case may be worth while reporting.

## CASE REPORT

C. F., a female, age thirty-three, was admitted to the Cooper Hospital medical service on December 8, 1945, with the chief complaint of diarrhea for two months and loss of considerable weight.

Laboratory findings showed general low blood count with increase in eosinophiles; red blood cells 2.8; hemoglobin 49 per cent; white blood cells 6,056; polymorphonuclears 53 per cent; lymphocytes 15; eosinophiles 23 per cent; and somewhat accelerated sedimentation rate. Blood chemistry was within normal limits. The stool was negative for ovae and parasites and repeatedly negative for *Bacillus abortus*, malaria and Wassermann reaction, doubtfully negative for paratyphoid and typhoid and positive for occult blood. Chest X-rays showed the trunk shadows to be rather heavy but no definite lung changes. General physical examination revealed nothing of special importance.

The proctologic examination was negative. On digital examination a narrow, firm, funnel-shaped stricture was found, beginning about 4 cm. above the anal orifice, allowing a French 16 bougie barely to be passed at its narrowest point. Some blood-tinged mucoid discharge was present. No fistulous tract or esthiomine were observed. The character of the narrowing suggested lymphopathia venereum as ideologic origin. A Frei test was positive—three plus.

She was dilated from a French 16 to 36 bougie, thereafter digitally and low pelvic diathermy in conjunction with sulfathiazole were given. She was discharged from the hospital as improved on December 24, 1945, and kept under observation in the Out-patient Department until the beginning of March, 1946. At this time symptoms of begin-

ning intestinal obstruction prompted an x-ray study on March 8, 1946, which revealed, besides the rectal stricture, narrowing of the lumen of the ascending colon near the hepatic flexure. The terminal ileum likewise appeared narrow and spastic suggesting localized colitis and terminal ileitis. (Fig. 1.)

A barium enema was given on March 8, 1946. In the examination of the large bowel there was a definite constant narrowing of the rectum extending from the anus up to a point just above the rectosigmoid. The walls of the rectum appeared somewhat thickened and the process appeared to be of relatively long-standing. The sigmoid loop appeared fore-shortened. Narrowing of the proximal ascending colon just below the hepatic flexure was also noted. The mucosa in this area appeared hyperplastic; the terminal ileum showed areas of spasticity and dilatation. No other abnormalities were observed in the large bowel. In the contrast film with air these findings were confirmed.

Diagnosis: Rectal stricture with suggestive localized colitis of the proximal ascending colon, etiology indeterminate.

When obstructive symptoms got more pronounced, the patient was re-admitted on the surgical service April 24, 1946. Her complaints were frequent colicky pains in the right upper quadrant and vomiting after eating meat. General examination and laboratory findings on admission showed nothing extraordinary. When conservative treatment failed to improve her condition an exploratory laparotomy was done after suitable preparation on May 13, 1946.

A left paramedian incision was made. On opening the peritoneal cavity no abnormal fluid was observed. The small bowel was seen to have many small nodules about 0.5 cm. in diameter on its surface. There was surrounding induration at the bases of the nodules. The ascending and descending colon was adherent in the lateral gutters and thickened. The descending colon, sigmoid and rectum especially were greatly thickened and indurated. The liver felt nodular. A nodule from the intestinal surface was excised for biopsy and the abdomen was closed in layers without drains.

Tentative diagnosis: Granuloma of ileum, possible regional ileitis.



FIG. 1. Anteroposterior view showing narrowing of the rectum—lymphopathia stricture. The deformity of the terminal ileum, cecum and ascending colon is presumably due to tuberculosis (reversed print).

The pathologic examination revealed the following: The specimen was a nodule of white tissue 8 by 6 by 5 mm. On section the tissue was gray white, homogenous and fairly firm. The section revealed chronic granulomatous inflammatory tissue. The tubercle formation was that seen in tuberculosis with many giant and epithelioid cells. Only slight necrosis was present. A stain for tubercle bacilli was negative. Due to this, regional ileitis was considered more seriously although it was believed that tuberculosis was not necessarily ruled out.

Revised diagnosis: Terminal ileitis and lymphopathia venereum.

An uneventful recovery and considerable improvement followed under general supportive postoperative treatment including several blood transfusions and the patient gained some weight. Repeated chest x-rays on May 23 and May 29, 1948, showed a definite increase in opacity of the apices suggestive of tuberculosis but the sputum was negative.

The patient was discharged from the hospital on June 3, 1946, and followed up in the Out-patient Department. The rectal stricture appeared unchanged and could be kept dilated digitally. Bowel movements were fairly regular. Pulmonary x-rays on June 9, 1946, showed some improvement.

On August 21, 1946, lung x-rays showed increasing density in both upper interspaces and the patient was admitted to the Bonnie Burn Sanatorium in Union County, New Jersey.

Here, according to the report we received, further lung x-rays and Mantou test proved tuberculosis clinically although the sputum was negative. When the advancing gastrointestinal involvement produced obstructive symptoms again, a cecostomy was resorted to on November 27, 1946.

During the procedure a narrow stricture of the ascending colon was discovered which would not admit the index finger whereas the small intestine appeared normal at this time. A McBurney's incision was made on the right side and the cecum and appendix delivered into the wound with difficulty because of inflammation in the cecum. The small intestine presenting appeared normal. The cecum was tied down in one layer into the peritoneum and in another layer to the muscle and fascia. The appendix was removed. During the process the cecum was inadvertently entered and left open. Palpation of the other portion of the ascending colon revealed a stricture 3 inches from the top. The stricture would not admit the index finger. A tube was passed into the cecum as far as the stricture and sulfanilamide crystals were left in the wound.

Proctoscopic examination on April 29, 1947, showed the rectal stricture nearly closed. After general improvement under penicillin and sulfadiazine, the patient was discharged from the sanatorium on May 5, 1947.

She came to the Cooper Hospital Out-patient Department again on September 11, 1947, and October 1, 1947. At this time she had adjusted herself fairly well to her cecostomy. The rectal stricture appeared completely closed. Her general condition was satisfactory and she had gained some weight. On February 18, 1948, the cecostomy opening appeared rather narrow. The rectal stricture admitted a French 18 bougie. She reported that at times small amounts of feces were expelled by rectum. She appeared cheerful and generally improved. Thorough follow-up studies and x-rays are contemplated as soon as this can be arranged since the patient lives quite a distance from the hospital.

The patient has received low pelvic diathermy and rectal dilatations at regular intervals. Fairly sized formed stools are passed by rectum. The ileostomy is closing gradually and leaks fluid stools only occasionally. Pulmonary x-rays show satisfactory arrest of her chest condition. Her general condition and mental attitude was encouraging when last seen in October, 1948.





# BENIGN LYMPHOMA OF THE RECTUM

DAVID MILLER, M.D.

Los Angeles, California

IN the submucosa of the normal, human, large intestine one finds numerous scattered lymph nodules which frequently show germinal centers. The cecum and appendix are especially rich in these nodules. Frequently the lymphatic tissue penetrates the muscularis mucosa and extends to the under-surface of the epithelium pushing the mucosa ahead of it and presenting small elevations. This process may continue with the formation of nodules or tumors; even the mucosa adjacent to the nodule may become involved in an ulcerative condition.

One finds in the literature many cases of tumors of the rectum of lymphoid tissue origin. Kallet and Saltzstein in 1932 prepared a report entitled, "Sarcoma, Melanoma and Lymphosarcoma of the Rectum." In 1933 N. D. Smith of the Mayo Clinic reported on lymphosarcoma of the rectum and sigmoid. Kleiner in 1938 reported a case of lymphosarcoma of the anus. In 1938 Tucker and Helwig published a paper on proctologic tumors. Hayes, Burr and Pruitt in 1939 reported a case of their own along with twenty other cases reviewed in the literature of simple lymphomas of the rectum and in their excellent report reviewed the lymphoid tumors of the colon and rectum. Tom E. Smith of Dallas, Texas, while in the service of the U. S. Army in 1943, reported three cases of "Primary Lymphoid Tumors of the Rectum Resembling Internal Hemorrhoids." He was the first, I believe, to report a benign lymphoid tumor of the rectum resembling an internal hemorrhoid. I have one case to add to this list. Recently, Dr. Fred Bradford of Los Angeles has found another.

## CASE REPORT

My patient was a white, married woman fifty-four years of age. She was referred to me because she complained of protrusion of a small lump through the anal orifice when straining at stool and which was easily replaced after evacuation. Her physician had given her a complete physical examination including a gastrointestinal series and roentgenologic study of the colon. The latter revealed diverticulosis of the descending and sigmoid colon of which the patient had no symptoms. She had no complaints other than the appearance of a slight amount of bright red blood

occasionally on the toilet tissue and the feeling of the protrusion of this small mass from the rectal outlet at bowel movement.

During proctologic examination an enlarged internal hemorrhoid was discovered in the right posterior quadrant and medium size external and internal hemorrhoids in other areas. The remainder of the examination of the anus, rectum and sigmoid was negative. The enlarged mass when viewed anoscopically appeared to be an elevation of the mucosa that was slightly reddened but not ulcerated and was about 1 cm. in diameter. It felt like a thrombus and was movable over the underlying structures but the mucosa was adherent to it.

Hemorrhoidectomy was performed June 1, 1946. The patient made an uneventful recovery and in four weeks the wounds were completely healed. The pathologist reported the specimen to be a nodular mass of lymphatic tissue with a general follicular structure. There was some fibrosis seen. There was a general increase in the loose lymphocytic tissue in the mucosa and submucosa. The pathologist's diagnosis was benign lymphoma of the rectum.

Follow-up examination of the patient every three months for one and one-half years showed no recurrence and recheck of all accessible lymphoid gland areas showed no enlargement. Roentgen therapy was not given because the tissue was benign and healing took a normal course.

## CONCLUSION

In conclusion I wish to emphasize the importance of microscopic study of all tissue removed during surgical operations, particularly if the tissue is removed from the anorectal region.

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# NEW SCLEROSING AGENT FOR HEMORRHOIDS\*

## A THREE-YEAR STUDY

MAX P. COWETT, M.D.

*New York, New York*

A THREE-YEAR study of a new sclerosing solution for hemorrhoids was started in September, 1944, at the New York

TABLE 1  
NUMBER OF CASES

	1944	1945	1946	1947	Total
New York University.....	19	51	47	39	156
Private.....	15	47	30	32	124
Bellevue.....	..	..	55	53	108
All institutions.....	34	98	132	124	388

Average number of injections: 8

University Rectal Clinic. In 1946 and 1947 the same solution was used at the Rectal Clinic of the Third Division at Bellevue Hospital.

Many solutions have been used in the injection treatment of hemorrhoids. The purpose of this paper is to give to the members of The American Proctologic Society our observations and results over a three-year period.

Sclerosing therapy is not to be thought of as a rival to surgery nor must it be used indiscriminately. It is not my premise in this report to give the indications and contraindications for the injection treatment of hemorrhoids. A number of cases in this group were best suited for surgery but because of such factors as cardiac decompensation, marked hypertension, renal disease and pulmonary tuberculosis we tried sclerosing therapy.

The solution used was a branched chain sodium alkyl sulfate (Sodium Sotradecol). The original experimental work on this particular solution was done by Reiner.<sup>1</sup> He concluded that this solution produced thrombi more readily with less tissue reaction and systemic toxicity than any of the other sclerosing agents such as phenol, quinine urea or any of the soap-type solutions. Cooper,<sup>2</sup> Hirschman<sup>3</sup> and others have reported very favorably on the use of this solution in the injection therapy of varicose veins.

In this study an attempt was made to evaluate the extent of obliteration of the injected hemorrhoid, the extent of fibrosis and the side effects such as pain, systemic reaction, irritation, inflammation, sloughing or bleeding.

The injection of 1, 2, 3 and 5 per cent solutions were attempted and it was found that in the higher percentages there was more irritation and a greater incidence of sloughs. For the past two years only 1 and 2 per cent solutions have been used and this was found to be satisfactory. It was also found that pain was more frequent when concentrated solutions were used.

The technique used was to inject into the hemorrhoidal mass starting with 0.3 cc. and increasing dosage to a maximum of 1.5 cc. at the fifth or sixth injection. The average number of injections for each case was eight, the minimum four and the maximum fifteen.

To study the effects of this solution further hemorrhoids requiring operation were injected. This was done at intervals of from 24 to 168 hours before operation. The excised hemorrhoid was examined histologically and the amount of fibrosis and tissue reaction was noted.

The tissue changes were not unlike those reported by Bacon<sup>4</sup> with quinine urea, Pruitt<sup>5</sup> with phenol in oil and Dukes and Anderson<sup>6</sup> also with phenol in oil.

The pathologic studies incidental to this report were done by Dr. J. W. Hall, Third Division, Bellevue Hospital.

We have numerous pathologic specimens but for the purpose of this report we have added hereto illustrations of four cases showing the pathologic changes following injection.

CASE 1. F. W., No. 17517. Twenty-four hours after injection microscopic examination revealed several small areas of intra-epithelial vesiculation. The underlying corium was edematous and diffusely infiltrated with lymphocytes. Throughout the section were many dilated hemorrhoidal veins.

\* From the Department of Surgery, New York University College of Medicine and Third (New York University) Surgical Division, Bellevue Hospital, New York, N. Y.

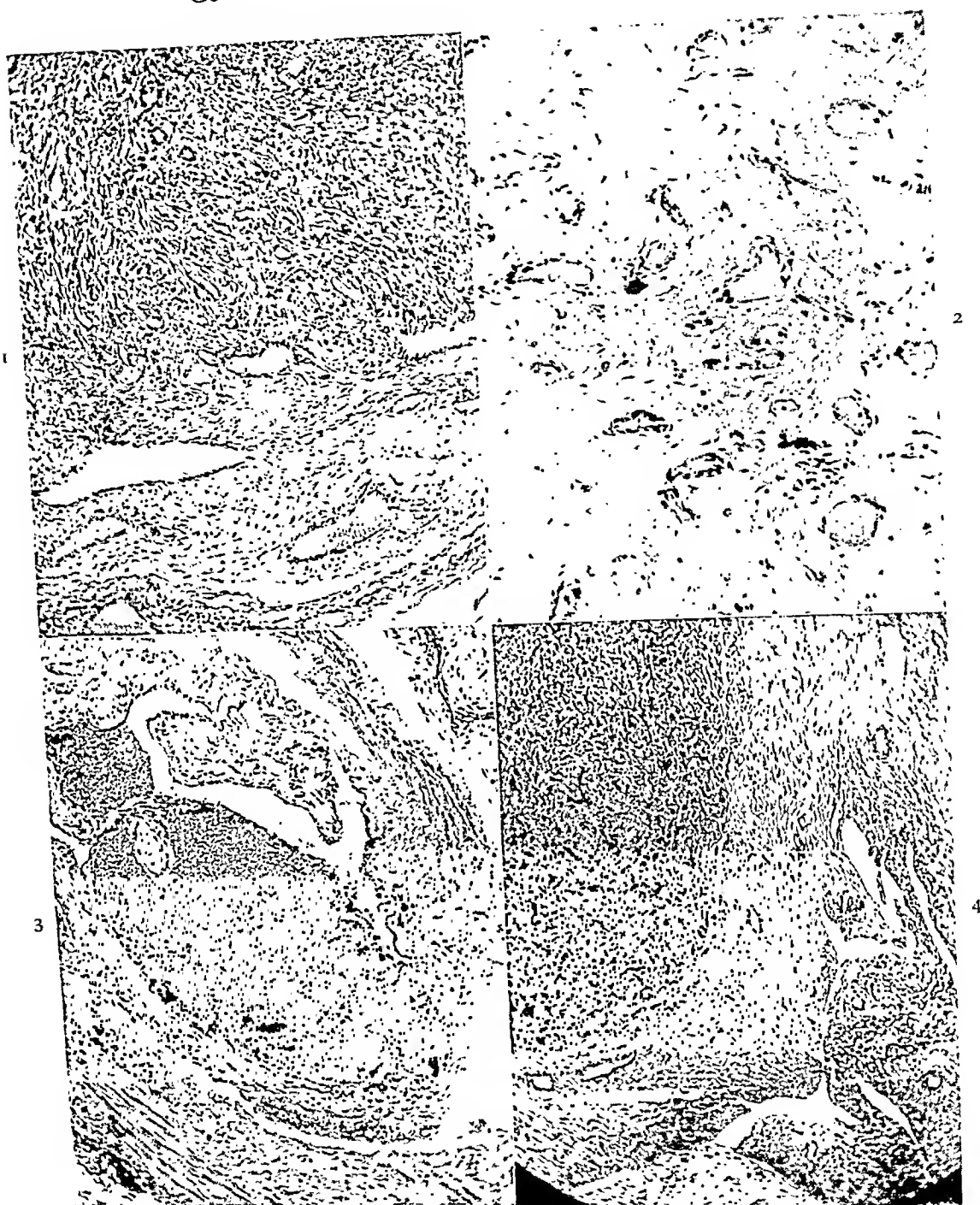


FIG. 1. Photomicrograph of resected hemorrhoid twenty-four hours after injection showing edema and infiltration with lymphocytes and considerable amount of extravasated lymph.

FIG. 2. Photomicrograph of resected hemorrhoid thirty-six hours after injection showing an acute inflammatory reaction with infiltration of polymorphonuclears and lymphocytes.

FIG. 3. Photomicrograph of resected hemorrhoid 124 hours after injection showing small thrombi with organization and considerable amount of fibrous tissue replacement.

FIG. 4. Photomicrograph of resected hemorrhoid 160 hours after injection showing fibrous tissue incompletely covered by squamous tissue. Elastic tissue stain shows almost complete loss of elastic tissue from the walls of the veins.

A considerable amount of extravasated lymph was noted. (Fig. 1.)

Pathologic diagnosis: Hemorrhoids with acute inflammatory reaction.

CASE II. F. M., No. 2667. Thirty-six hours after injection microscopic examination of section

the site of injection. Rosser<sup>7</sup> has described submucous tumors which occurred after the use of phenol in oil. We have not encountered any such tumors. In a series of 388 cases, twenty-two patients or 5.7 per cent failed to show any evidence of fibrosis. If the cases that

TABLE II

	1944		1945		1946			1947			Total	Per-centage
	N.Y.U.*	Pvt.†	N.Y.U.	Pvt.	N.Y.U.	B.H.‡	Pvt.	N.Y.U.	B.H.	Pvt.		
Fibrosis.....	18	15	47	46	44	50	29	39	52	32	372	95.9
Pain at time of injection.....	2	1	4	1	3	5	1	1	1	2	21	5.4
Sloughing.....	5	0	8	9	12	1	1	4	5	0	45	11.6
Inflammation or proctitis.....	0	0	1	0	1	1	0	0	0	0	3	.8
Systemic reaction..	0	0	1	0	0	0	0	0	0	0	1	.3
Bleeding.....	1	0	2	1	1	0	0	0	0	0	5	1.3

\* New York University

† Private.

‡ Bellevue Hospital.

showed stratified squamous epithelium and rectal mucosa with underlying connective tissue stroma. In the connective tissue stroma there were numerous congested blood vessels of varying sizes. The specimen showed an acute inflammatory reaction with moderate to marked edema and infiltration of polymorphonuclears and lymphocytes. (Fig. 2.)

Pathologic diagnosis: Acute inflammatory reaction.

CASE III. F. Q., No. 5081-46. One hundred twenty-four hours after injection microscopic examination revealed numerous veins. A few of these showed small thrombi with organization. There was a considerable amount of fibrous tissue replacement. (Fig. 3.)

Pathologic diagnosis: Hemorrhoid with thrombosis and fibrous tissue replacement.

CASE IV. L. G., No. 3315-45. One hundred sixty hours after injection microscopic examination of section showed fibrous tissue incompletely covered by squamous epithelium. In only one area were veins visualized. Elastic tissue stain showed almost complete loss of elastic tissue from the walls of the veins. (Fig. 4.)

Pathologic diagnosis: Hemorrhoid with fibrous tissue replacement.

One of the first observations made in studying this solution was the early fibrosis that occurred. Fibrosis usually develops four or five days after injection. This is determined by digital examination revealing induration at

were unsuitable for injection were eliminated, we could have obtained fibrosis in a greater number of patients.

Sloughing occurred in fifty-three cases or 11.6 per cent. This is a rather high incidence but we considered every ulceration although slight to be a slough. The sloughs were very superficial and in no case was any tissue destruction seen. In a teaching institution various individuals perform the injections. This may account for the higher percentage of sloughs in the clinic cases. In the private patient group with one individual injecting the incidence of sloughs is low. In 1947 after we decided on the use of 1 to 2 per cent solutions the percentage of sloughs in all groups was greatly reduced.

Pain at the time of injection was noted in twenty-three cases. The pain was slight and lasted only one or two minutes. Pain developing several hours after injection was noted in eight cases which had been treated with a higher concentration of the solution during the initial period of this study.

Inflammation or proctitis occurred in three cases. One patient had a systemic reaction, chills and fainting sensation two or three hours after injection. This patient had a severe avitaminosis, hypoproteinemia and secondary anemia and edema.

Only those patients whose chief complaint was rectal bleeding were injected. Of the thirty-four patients injected in 1944 all but one were followed. In this group only one case had recurrence of bleeding. This patient had slight bleeding for three days in 1945 but none since.

In 1945 fifty one clinic and forty-seven private patients were treated. Of these two patients in the clinic group and one in the private group had a recurrence of bleeding. Bleeding in all these patients was transitory and lasted one or two days.

In 1946 there was a total of 132 patients treated and all but nine in the Bellevue Hospital group were followed. Only one patient has had a recurrence of bleeding and this according to the patient lasted one day. None of the cases with transitory recurrence of bleeding was given further injections.

We have practically complete protocols on all cases seen in the past three years and only five cases or 1.3 per cent had recurrence of bleeding. This approaches the results obtained by Milligan<sup>8</sup> in his paper published in 1939 who states that 98 per cent of patients with first degree hemorrhoids are cured by injection. From a review of 26,262 collected cases in which the patients were treated by injection, Kilbourne<sup>9</sup> estimated that recurrence took place in at least three years. The group we

studied was very much smaller but it is our opinion that following the use of Sodium Sotradecol recurrence will be very much less.

#### SUMMARY

Sodium alkyl sulfate in a 1 or 2 per cent solution is a safe sclerosing agent to use in the injection therapy of hemorrhoids. In our hands this solution is more effective than solutions previously used, such as quinine, synasol or phenol. Fibrosis occurred more readily and patients have been symptom-free in less time than we have observed in using other sclerosing solutions.

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# PERIANAL INFECTION IN THE TUBERCULOUS PATIENT

## CLINICAL NOTES

JULIUS GERENDASY, M.D.

Elizabeth, New Jersey

FOR the purpose of this presentation 204 unselected tuberculous patients examined for anorectal symptoms in the proctologic

ally corresponds closely to that of the latter. The greatest number were in the third and fourth decades of life; thirty-two of the surgi-

TABLE I

Sex	Patients with Fistulas	Surgical Fistulas	Subgroup Incision and Drainage	Total
Males.....	66	40	26	79
Females....	13	5	8	

Age	Thirty to Fifty	Under Thirty	Over Fifty	
Males.....	33	20	13	79
Females....	8	5	..	

clinic of the Berthold S. Pollak Hospital for Chest Diseases, September, 1943 to October 1946, were reviewed. The variety of lesions found was so extensive as to make desirable a selective analysis of the material. Therefore, this discussion will be confined exclusively to lesions of the "fistula" type, *which henceforth includes abscesses, sinuses and fistulas*. Seventy-nine patients came under this classification, including forty-five surgically treated patients and thirty-four in whom for various reasons only incision and drainage was performed. This subgroup was included since they presented the clinical characteristics of perianal suppurative lesions in the tuberculous and, by increasing the total number under consideration, they gave an added value to the conclusions.

### SEX AND AGE

As was to be expected males predominated at the ratio of sixty-six males to thirteen females. (Table I.) In our total series of rectal disorders, there were 151 males and 53 females. Since these "fistulas" are a complication of pulmonary tuberculosis, the age incidence natur-

TABLE II

NATIONAL TUBERCULOSIS CLASSIFICATION AND SPUTUM STATUS IN SEVENTY-NINE PATIENTS WITH ANAL "FISTULAS"

National Tuberculosis Association classification <sup>1</sup>	Surgical Group	Sub-group Incision and Drainage	Percentage
Non-tuberculous.....	2	3	6.3
Minimal and moderately advanced.....	8	2	12.6
Far advanced.....	35	29	81.1
Sputum status			
Positive.....	32	29	77.2
Negative.....	7	4	13.9
Not reported.....	6	1	8.8

cally treated patients were in this group, six patients were over forty and five under twenty. Two had arrested cases. In the subgroup of incision and drainage seventeen patients were in the third and fourth decade, four were over forty while twelve were under thirty years of age. Of the total number more than 60 per cent were in the third and fourth decades. In the entire group of seventy-nine patients the youngest was seventeen and the oldest sixty-six years of age. In our entire experience we cannot recall more than two or three children with tuberculous anal infection.

### CLASSIFICATION ACCORDING TO EXTENT OF PULMONARY INVOLVEMENT

Most of the patients admitted had a mixed exudative and proliferative type of tuberculosis, frequently with cavitation. In the average yearly population of 560, 89 per cent had advanced pulmonary lesions. In our series of seventy-nine "fistula" patients all but two had

active pulmonary tuberculosis. In the forty-five surgically treated patients one had minimal, seven had moderately advanced and thirty-five had far advanced tuberculosis (Table II.) In the more seriously ill subgroup of incision and drainage patients, three were

there were fifteen anosubcutaneous infections, nine ischiorectal, seven postnatal and one supralelevator "fistula." In two patients the records were incomplete. (Table IV.)

*Internal Openings.* In contrast to previous reports there were no internal openings in the

TABLE III  
ANATOMIC CLASSIFICATION PERIANAL "FISTULAS" IN THE TUBERCULOUS  
(Surgical Group)

Perianal Anosubcutaneous Fistulas		Ischiorectal		Postanal			Horseshoe Lesions	Supralelevator	Remarks
Tuberculous Inflammation	Mixed Infections (Clinically Tuberculous)	Tuberculous Inflammation	Mixed Infections (Clinically Tuberculous)	Tuberculous Inflammation	Mixed (Clinically Tuberculous)	Pyogenic			
P. B. E. B. J. B. J. C. A. F. A. S. C. P. E. K. F. K.	R. B. J. F. J. T. R. M. M. H. W. K. J. R. J. S. A. H.* J. L. C. R. L. D.	J. B. J. D. E. F. J. G. J. H. C. K. E. K. F. P.	M. O. S. A. A. W. W. H.	J. F. R. D.	C. S. A. D. M. H. F. R.	J. W. M. M.	L. Mc* L. M.*	H. C.* H. H.	The anatomic classification is somewhat arbitrary in the case of ischiorectal fistulas. It is based chiefly on the involvement of perianal tissues sufficiently to penetrate this space
Total 9	12	8	4	2	4	2	2	2	

\* Positive for tuberculous inflammation

non-tuberculous, two had moderately advanced and twenty-nine had far advanced pulmonary tuberculosis. These figures indicate that the incidence of perianal "fistulas" increases with the extent of pulmonary tuberculosis.

*Positive Sputum.* In the series of forty-five surgically treated patients the incidence of positive sputum was 71 per cent; in the subgroup of thirty-four incision and drainage patients it was 85 per cent. (Table II.) Therefore, the total percentage in seventy-nine patients was 77 per cent.

*Anal Fistulas.* The forty-five surgically treated patients included twenty-one subcutaneous anal abscesses, twelve ischiorectal, eight postanal, two horseshoe and two supralelevator "fistulas." (Table III.) In the subgroup of thirty-four incision and drainage subjects

great majority of our patients. Tables V and VI show that in thirty of the surgical patients and in twenty of the incision and drainage subgroup there was no such opening. Fourteen had pinpoint internal openings and twelve had ulcerated internal openings. In three cases the question could not be determined. We are unable to explain the discrepancy between our findings and those of others.<sup>2-5</sup>

When present, the internal opening was most often located to the right or left of the posterior or anterior midline of the anal circumference near the junction of the modified anal skin with the rectal mucosa. Some were in the lateral anal margins and a few at six or twelve o'clock. In three cases in which the tuberculous infection originated in a crypt of Morgagni the result was a deep ulcerated sinus. It is possible that

TABLE IV  
ANATOMIC CLASSIFICATION OF PERIANAL "FISTULAS" IN  
THE TUBERCULOUS  
(Subgroup, Incision and Drainage)

Perianal Anosubeu- taneous	Ieshio- rectal	Postanal	Supra- levator	Not De- termined
J. C. W. D. T. B. R. G. G. E. J. G. A. H. P. R. J. R. G. S. R. H. G. M. F. B. R. S. R. M.	R. H. H. H. C. S. A. A. G. G. T. P. R. T. E. K. T. Q.	E. C. J. G. F. S. L. D. F. P. J. D. A. H.	G. MeP.	E. M. G. O'C.
Total 15	9	7	1	2

TABLE V  
INCIDENCE OF INTERNAL OPENING IN CHRONIC PERIANAL  
"FISTULA"  
(Surgical Group)

Primary Internal Opening Absent	Pinpoint Internal Opening	Ulcerated Internal Opening
P. B. J. G. W. D. J. B. H. H. F. P. R. B. A. H. J. R. J. B. E. K. C. R. H. C. E. K. R. G. J. D. J. L. W. H. R. D. L. M. A. S. A. F. R. M. J. T. E. F. L. Me J. W. J. F. C. P. A. W.	L. D. C. K. F. K. M. M. M. O. J. S. M. W.	A. A. J. C. A. D. J. E. J. H. M. H. S. K. C. S.
Total 30*	7†	8‡

\* Sixteen of these patients with histologically positive tuberculous sinuses had no primary anorectal internal opening; thirteen patients with mixed infection but clinically tuberculous sinuses had no internal opening; one patient with a primary pyogenic abscess had no internal opening.

† In two tuberculous sinuses a minute opening was present; in three mixed infections a minute internal opening was present; in two pyogenic abscesses a minute opening was present.

‡ Three tuberculous sinuses with an ulcerated internal opening; five with mixed infection had ulcerated internal openings. All the surgical patients had an external opening except one who had an ulcerated internal opening only.

some of the twelve ulcerated internal openings were due to crypt infection. Apparently the absence of a *primary* internal opening in most cases of tuberculous perianal "fistulas" is an important characteristic of this type of infection.

TABLE VI  
INCIDENCE OF INTERNAL OPENINGS (ABSCESSSES, SINUSES  
AND FISTULAS)  
(Subgroup, Incision and Drainage)

Internal Opening		Internal Opening Not Ac- counted For	Remarks
Absent	Present		
J. C. W. D. J. G. A. H. G. E. R. H. J. R. G. S. P. R. T. B. R. H. H. H. E. M. G. MeP. L. D. G. O'C. T. Q. R. S. C. S. J. G.	E. K. R. G. R. M. F. B. A. A. E. C. T. P. F. S. R. T. A. H. G. M.	G. G. F. P. J. D.	Primary incision and drainage was performed on twenty subjects Spontaneous rupture occurred in six patients Chronic discharging fistulas (from 1 month to 12 years) were present in eight patients There were twenty-six males and eight females in this subgroup
Total 20	11	3	

PATHOGENESIS OF PERIANAL INFECTION

We agree with others<sup>6-8</sup> that it is not safe to diagnose anorectal tuberculosis in the absence of active extrarectal tuberculosis or a history of previous infection. Infection leading to "fistula" in the tuberculous is generally supposed to originate in a crypt and burrow its way into the perianal tissue.<sup>3,4,9,10</sup> This is presumed to be the internal opening of the lesion, but we have not found it to be so. A typical tuberculous perianal infection rarely has its demonstrable origin in the rectum. Even in cases of mixed pyogenic and tuberculous infection an internal opening is the exception.

The usual mode of infection is the swallowing of sputum containing tubercle bacilli thus contaminating the feces with viable and viru-

lent organisms which spread to the perianal tissues by way of the lymphatic and blood vessels and by direct extension. Even a large perianal abscess frequently appears fully developed at the anal margin without any preceding symptom referable to the rectum.<sup>11-13</sup>

TABLE VII  
INCIDENCE OF CHRONIC PERIANAL INFECTIONS  
(ABSCESSSES, SINUSES AND FISTULAS)  
(Surgical Group)

Histologically Positive for Tuberculous (primary) Inflammation*	Pathologic Report		Chronic Inflammation	
	Clinically Tuberculous Fistulas with Secondary Pyogenic Infection	Primary Pyogenic Infection (Tuberculous Superimposed, clinically Tuberculous)	Clinically Typical Tuberculous Sinus	Primary Pyogenic Sinus of Fistulas
P. B. J. G. J. B. J. H. E. B. C. K. J. B. E. K. H. C. F. K. J. C. L. Mc R. D. C. P. E. F. F. P. A. F. A. S. J. F. E. K. J. D. J. D.	R. B. J. D. M. H. J. S. A. W. W. H.	S. A. A. D. L. D. H. H. A. H.* L. M.† R. M. C. S.	J. F. F. K. J. L. M. O. J. R. C. R. J. T.	M. M. J. W. M. W.
Total 21	6	8	7	3

\* Clinically typical tuberculous sinuses with seropurulent discharge.

† Pathologic report of tuberculous inflammation added to twenty-one in the first column, the total is twenty-three histologically tuberculous perianal infections.

The infection apparently spreads from the rectum through the lymphatic channels<sup>13,14</sup> directly beneath the sphincter muscles and the squamous lining of the anal canal.

In the usual type of anal tuberculosis the earliest demonstrable lesion appears to be a slightly tender nodule in a localized segment of the anal verge. At this nodular stage it may regress spontaneously, depending on the virulence of the organism and the resistance of the

patient. If the nodule develops into a so-called primary, acute, "pure" abscess, aspiration may reveal a pure culture of the tubercle bacillus.<sup>15</sup> Tables VII and VIII indicate the pathologic nature of the various subdivisions in seventy-nine patients. When the nodule continues to

TABLE VIII  
INCIDENCE OF PERIANAL INFECTION (ABSCESSSES, SINUSES AND FISTULAS)  
(Subgroup, Incision and Drainage)

Histologically Positive for Tuberculous Inflammation (Sputum, All Far Advanced Cases)	Pathologic Report, Chronic Inflammation		Clinical or Laboratory Status Not Determined
	Clinically Tuberculous Abscess with Secondary Pyogenic Infection	Primary Pyogenic Fistulas	
J. C. W. D. G. E. R. G. J. G. A. H. R. H. P. R. J. R. G. S. R. S. F. B.	T. B. R. M. R. H. H. H. E. M. G. M. C. S.	G. O'c. T. Q. E. K. F. P. J. D. A. H.	A. A. E. C. L. D. G. G. J. G. G. McP. T. P. F. S. R. T.
Total 12	7	6	9

enlarge, it usually spreads along the perianal subcutaneous lymphatic network. There is little pain or tenderness and the temperature is often not higher than that already present as a result of tuberculosis elsewhere in the body. Later the nodule becomes reddened over a small area and a thin seropurulent discharge appears through a minute external opening. A probe passed through the opening can be moved freely directly under the skin, indicating the superficial nature of the infection. In two or three weeks the discharge ceases, the symptoms subside and the wound is apparently healed, but it remains a focus of infection. Acute infection may recur months or years later unless the lesion is surgically eradicated. In eighty-four patients with healed lung lesions with negative sputum Martin<sup>5</sup> found ten with posi-



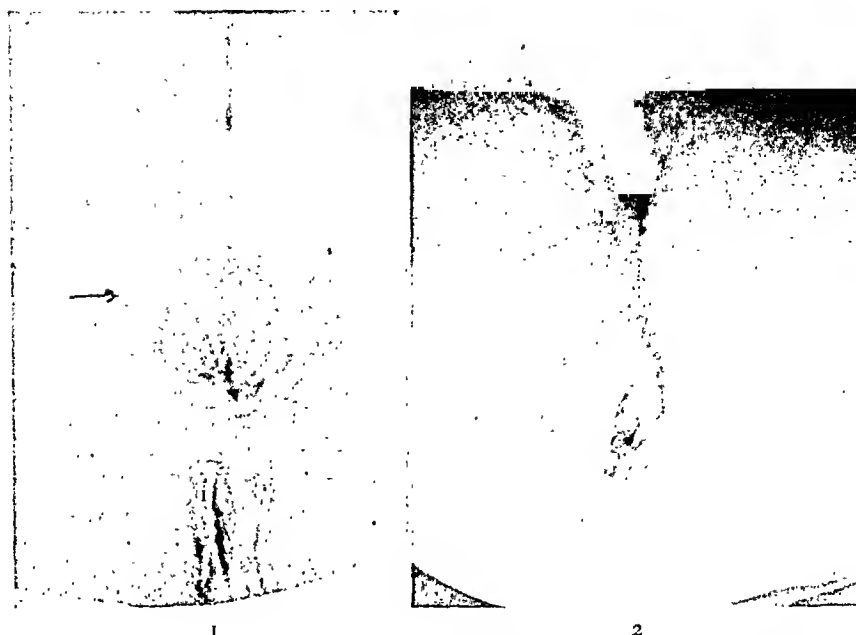


FIG. 1. Group 1, typical primary tuberculous abscess, characterized by a relatively painless, slightly elevated, subcutaneous perianal swelling with very little inflammatory reaction. (GRANET, E. and GERENDASY, *J. Quart. Bull. Sea View Hosp.*, 4: 445-452, 1939.)

FIG. 2. Group 1, removal of the overlying skin (shown in Fig. 1) reveals the superficial nature of this tuberculous infection as well as typical violaceous granulations.

tive tuberculous lesions in the anorectal region. Such a focus may cause auto-inoculation of the anal region<sup>4,11,16,17</sup> or be a factor in gastro-intestinal infection. The following case report confirms this:

#### CASE REPORTS

E. K., aged twenty-eight, a single female was admitted September 29, 1943, for surgical treatment of discharging perianal lesion. Active pulmonary tuberculosis with positive sputum was diagnosed in December, 1935. From then until May 1938 she was treated in a tuberculosis sanatorium. Her general condition was good until two months prior to admission when she developed a left perianal abscess. Spontaneous rupture and continuous discharge of seropurulent material persisted since its onset. Examination in the proctologic clinic revealed a minute opening in the left anterior perianal quadrant 3 inches from the dentate line. Probing showed the sinus to be subcutaneous with no internal opening. Surgical excision was done on October 6, 1943. Culture of the tissue was positive for tubercle bacilli. Complete healing was accomplished in five weeks.

That the preceding facts are not generally known is shown by the following case report on "Perirectal Sinus and Employability" taken from "Queries and Minor Notes"<sup>18</sup> with the erroneous answer:

"To the Editor:—Precedents are desired with regard to the employability of a person having a perirectal sinus presumably of tuberculous origin. The discharge is slight. There are no other open tuberculous lesions. The patient's state of health is stabilized and he is considered physically able to carry on his former work. Are esthetic and hygienic considerations so serious that his former employer should consider him unfit to work with other employees and to use the same lavatories? He belongs to the white collar class. (M.D., New Jersey)

"ANSWER: No precedents have been found to interfere with the employability of a person having a perirectal sinus due to tuberculosis, without other demonstrable lesions."

#### CLASSIFICATION OF LESIONS

Chronic discharging anal lesions in the tuberculous may be divided into five clinical groups on the basis of pathologic anatomy as follows: (1) primary tuberculous abscess; (2) tuberculous sinus with secondary pyogenic involvement; (3) pyogenic infection with secondary tuberculous involvement; (4) tuberculosis cutis orificialis; (5) primary pyogenic anal abscess. The first four groups are tuberculous "fistulas."

Group 1: *Primary Tuberculous Abscess*. This group is the most common type of tuberculous anal infection. (Figs. 1 and 2.) It is illustrated by the following case:

F. K., aged thirty-three a white male, had an infiltrative pulmonary process and a small cavity with contralateral dissemination. Examination of the sputum was positive. Examination in the proctologic clinic on November 11, 1943, revealed a tender, circumscribed induration involving the anterior anal region. There was a discharge of seropurulent material through a minute external opening. Probing showed the infection to be subcutaneous, extending along the anal margin but not involving the rectum. Palpation showed the central part of the area to be slightly depressed, somewhat tender and with a suggestion of liquefaction of tissues. Surgical excision of the entire infected area was done on November 18, 1943. The culture was positive for tubercle bacilli and excised tissue revealed tuberculous inflammation. Repeated reinfection of the perianal region, including the operative wound, delayed healing. He was discharged from the proctologic clinic as cured on July 9, 1944.

The foregoing case is not typical of all tuberculous anal infections. Certain important factors modify the degree of tissue involvement, two of which are: (1) the inflammatory reaction in the tissues caused by the tubercle bacillus *per se*, and (2) certain conditions in which pyogenic organisms are superimposed on or precede the tuberculous infection.

Group 2: *Tuberculous Sinus with Secondary Pyogenic Involvement*. This second group is characterized by pain in the anal region and rapid formation of a tender induration near the anal margin. The temperature may be one or two degrees above normal. If not excised, the abscess ruptures and discharges a frankly purulent material for a short time. There is a large ragged external opening surrounded by dusky or cyanotic skin which contains typical violaceous tuberculous granulations. (Fig. 3.) When a tuberculous sinus is secondarily infected with pyogens, the latter apparently soon disappears leaving a thin discharge which persists until excision.

C. P., a white male aged fifty was admitted December 14, 1945, with extensive bronchopneumonic cavernous process in both upper lobes as well as positive sputum. An extensive postanal abscess with indurated margins developed. There was a creamy, purulent discharge through a ragged

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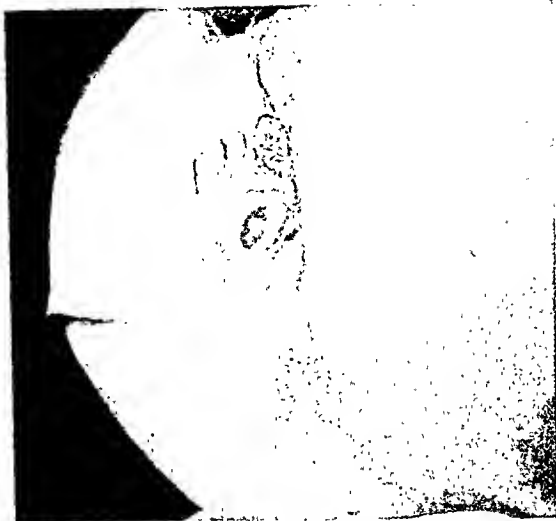
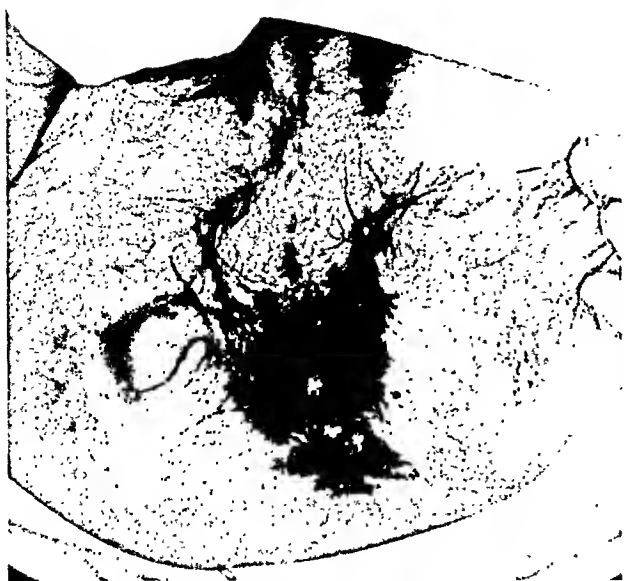


FIG. 3. Group 2, tuberculous sinus with secondary pyogenic infection characterized by a cavity lined with tuberculous granulation tissue. The external opening is surrounded by edematous cyanotic skin. (GRANET, E. and GERENDASY, J. *Quart. Bull. Sea View Hosp.*, 4: 445-452, 1939.)

external opening. Typical violaceous granulation tissue was present. Complete excision was performed with wound healing in eight weeks. Biopsy specimen showed tuberculous inflammation.

Group 3: *Pyogenic Infection with Secondary Tuberculous Involvement*. This group begins as a frankly pyogenic abscess with rapid formation of a circumscribed fluctuating mass, severe throbbing pain and a rise of temperature to 103 to 104°F. Incision and drainage evacuates a foul, frankly purulent material typical of a pyogenic infection. (Figs. 4 and 5.) The infection involves the deeper structures and a fairly large cavity is formed, lined with typical violaceous granulation tissue. Spread of the infection into the deeper tissues is clearly defined and does not extend beyond the fascial plane of perianal spaces. This type occasionally contracts to a fibrous tract and simulates the pyogenic fistula.

A. H., a white male aged fifty-seven, was admitted September 7, 1945, with pulmonary tuberculosis 11-A and positive sputum. On December 2, 1946, incision and drainage of the right ischioirectal abscess was done with an evacuation of a large amount of foul, purulent material. The culture was positive for *B. coli* and *Staph. aureus*. On December 14, 1946, complete excision of the infected sinus, including several hemorrhoids, was done. No internal opening was found. The wound healed completely in five months. The pathologic report showed tuberculous inflammation.



4

FIG. 4. Group 3, pyogenic abscess with secondary tuberculous infection; note the acutely inflamed circumscribed swelling, typical of a pyogenic abscess.



5

FIG. 5. Group 3, the evacuated pyogenic abscess revealed a definite cavity lined with violaceous granulations pathognomonic of tuberculous infection. (GRANET, E. and GERENDASY, J. *Quart. Bull. Sea View Hosp.*, 4: 445-452, 1939.)

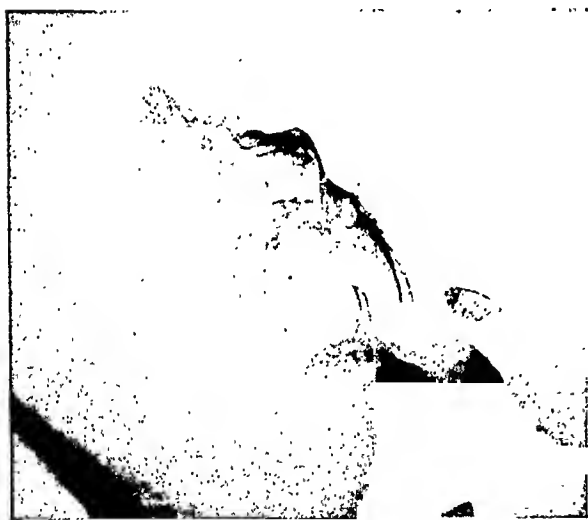


FIG. 6. Group 4, tuberculosis cutis orificialis. The infection advances with progressive destruction of tissue in a patient with rapidly progressing tuberculosis and poor resistance. (GRANET, E. and GERENDASY, J. *Quart. Bull. Sea View Hosp.*, 4: 445-452, 1939.)

Group 4: *Tuberculosis Cutis Orificialis*. This group is characterized by ulceration beginning either at the anal margin or at the mucocutaneous junction. The condition is progressive and destroys the rectal mucosa or, more often, the perianal skin for several inches. We agree with Fansler and Potter<sup>19</sup> that it is a

terminal complication in a patient with poor resistance or a virulent type of tuberculous infection. (Fig. 6.) If combined with laryngeal tuberculosis, streptomycin usually cures the latter and may help to heal the anal lesion if this is not too extensive.

R. D., a white male aged forty-five, was admitted with an extensive bronchopneumonic cavernous process in both upper lobes as well as positive sputum. A large, progressively invasive postanal ulceration involved the rectal mucosa and adjacent skin but not the deeper structures. It was very painful. Surgery was contraindicated because of the patient's toxic condition. Grenz rays had no beneficial effect, and the patient died shortly after examination.

Group 5: *Primary Pyogenic Anal Abscess*. In this group the perianal abscess is typical of those caused by pyogenic organisms and the onset is the same: rapid formation at the anal margin of a painful fluctuating mass associated with tenderness and fever. It contains foul, purulent material and the cavity is lined with the usual pyogenic membrane. In the chronic stage it becomes the typical pyogenic fistula with a contracted fibrous tract and an external cicatricial opening. After surgical extirpation

healing is rapid and complete, usually within three or four weeks.

J. W., a white male aged forty, was admitted with partial consolidation of the right upper lobe and positive sputum. Creamy pus exuded through a small internal opening to the right of the posterior midline. The entire infected area was excised December 14, 1946. The wound healed in three weeks. Biopsy showed chronic inflammation (non-tuberculous).

In order to appreciate the clinical manifestations and understand the anatomic variations of tuberculous perianal infection a knowledge of the anal and rectal lymphatic network is essential.<sup>13,14,20</sup> Infection of the anorectal lymphatics explains in most cases the spontaneous appearance of abscesses at the anal margin without symptoms referable to the rectum.

Infection of the lymphatics in the anorectal region may be caused by: (1) Extension of rectal inflammation caused by contaminated stools through wounds and injuries of the rectal mucosa. Proctoscopy often reveals multiple erosions in the rectal mucosa due to rectal (stool) stasis or scybalous stools. Constipation is common in bedridden tuberculous patients. In our series of seventy-nine patients thirty-five had chronic constipation and several suffered from diarrhea. (2) Retardation of the rectal circulation due to rectal stasis and the sedentary position of these patients favors inflammatory processes about the anorectal region.<sup>21</sup> (3) The swallowed sputum containing tuberculous bacilli. The constant presence of these organisms in the rectum maintains the infection and encourages new lesions.

#### SUMMARY AND CONCLUSIONS

1. The subject of perianal infections in the tuberculous has been discussed from the point of view of its origin and development and the specific clinical characteristics.

2. A classification of the more common infectious anal lesions found in tuberculous patients has been introduced. Each group has been described and illustrated with case reports.

3. Certain characteristics of tuberculous perianal infection distinguish it from the ordinary pyogenic type of infection.

4. A diagnostic triad consists of the characteristic clinical picture of a tuberculous anal

lesion, its peculiar mode of development and the typical histologic structure of the tubercle.

5. A tuberculous perianal discharging wound is usually not a fistula but rather a sinus. The term fistula in connection with tuberculous perianal infection is improper terminology. It confuses this specific lesion with pyogenic fistulas. A cord-like fibrous tract is not the rule; it is usually a chronic abscess frequently superficial.

This is only one example which indicates that the entire subject of tuberculous anal infections, particularly as it appears in proctologic textbooks, should be revised. At present these contain little useful information. Emphasis should be placed on this disease as a specific entity caused and maintained by the tubercle bacillus. It is generally a complication of pulmonary or other extrarectal tuberculosis. The hypothetical relation of the ordinary type of pyogenic fistula to this condition should be omitted from all future considerations.

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# COLONIC ADENOMAS

ROBERT TURELL, M.D.

New York, New York

**R**ECORDED in this paper<sup>1</sup> are the results of a study of the incidence of colonic adenomas found on sigmoidoscopic ex-

The sigmoidoscopy was performed in the knee-chest position with a sigmoidoscope 25 cm. long and about 2 cm. in diameter with the

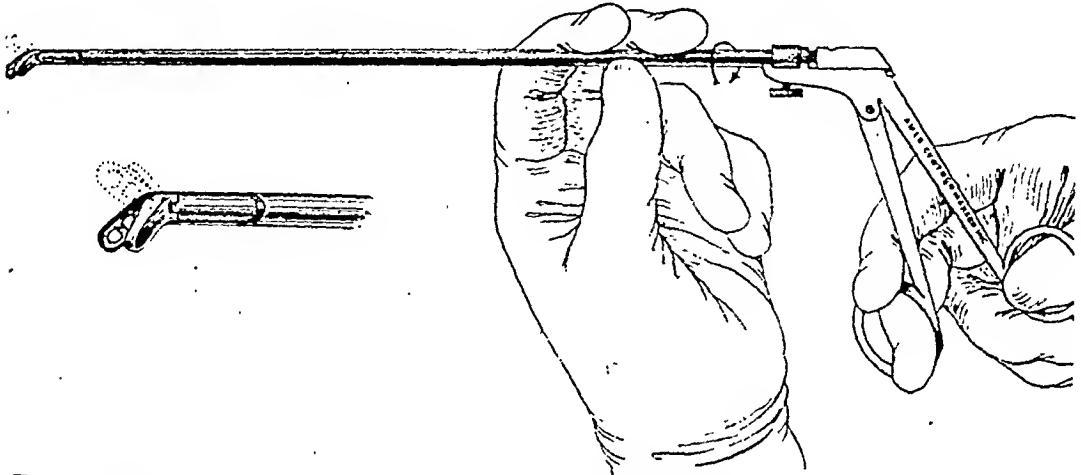


FIG. 1. Author's cold biopsy forceps. Note the angulation of the cutting mechanism and rotary movement (360 degrees) of shaft. (Courtesy of *Ann. Surg.*, J. B. Lippincott Co.)

amination in symptomless individuals; (2) the comparative results of a similar investigation of an equal number of patients with adenomatous polyps but who complained of bleeding from the rectum; and (3) an evaluation of therapy as applied to the latter group of patients as well as to other personal material.<sup>1</sup>

In this study adenoma is defined as a glandular structure which shows proliferation of the colonic epithelium without invasion of the wall of the bowel. This lesion is regarded as a benign neoplasm.

**Material and Method.** Three hundred eighty-six individuals under forty-five years of age who had had no intestinal complaints were subjected to a proctosigmoidoscopic examination. The preparation consisted of two lukewarm, plain water enemas taken at intervals of five to eight hours. The second enema was usually given approximately three hours before the time of sigmoidoscopy. Unless the mucosa was free from irremovable particles of feces or secretions which might obscure the visualization of small lesions, re-examination was performed after additional similar preparation.



FIG. 2. Microscopic section showing (1) normal colonic mucosa; (2) adenomatous polyp and (3) early malignant focus.

aid of gentle insufflation. Insufflation was especially useful for the visualization of 3 to 5 cm. of the sigmoid colon beyond the end or reach of the sigmoidoscope. Thus, a distance of 25 cm. or more of the terminal bowel was visualized in each instance.



FIG. 3. High power magnification of (2) in Figure 2.



FIG. 4. High power magnification of (3) in Figure 2.

Grossly mucosal elevations were recorded and either the entire lesion or pieces of tissue from the growth were removed for histologic studies with the aid of a cold biopsy forceps.<sup>2</sup> This has a shearing jaw mechanism with an angulation of 30 degrees and is provided with a shaft that can be rotated 360 degrees. (Fig. 1.)

In the case of sessile growths an attempt was made to secure representative biopsy specimens from the center, periphery and surrounding mucosa including basal submucosal structures in order to show the presence or absence of infiltration of the muscularis mucosae. In pedun-



FIG. 5. Application of tumor grasping forceps.



FIG. 6. Position of wire of electric snare around stalk of pedunculated polyp.

culated lesions pieces of tissue were usually removed from the body and sometimes from the base of the pedicle.

**Results.** This investigation elicited seven polyps and nine definite mucosal exerescences in fourteen patients. In one patient a combination of one pedunculated polyp and two mucosal exerescences was present. The mucosal exerescences varied in size from 1 to 4 mm. and were grossly sessile while three of the seven polyps were pedunculated. Their tips or bodies were over 0.5 cm. in diameter and the length of the pedicle varied from approximately 5 mm.

to 1 cm. All adenomas appeared grossly benign. Except for the characteristic elevation, the mucosal excrescences resembled the surrounding mucosa which was normal in all cases; the tips of the pedunculated polyps were redder or darker than the adjacent mucosa. Anal fibroepithelial polyps (hypertrophied papillae) were excluded from this study.

Histologically, the adenomas showed hyperplastic, relatively mature or well differentiated epithelial cells of uniform appearance supported by a central core of loose connective tissue and contained stalks of varying numbers, sizes, shapes and lengths. These differ from the normal mucous membrane of the colon where a single layer of cells lines the crypts and covers the surface. Some of the cells contained a rich complement of mucus and fully resembled normal colonic epithelium while other cells contained little or no mucus, were stratified and exhibited a fair number of mitoses. Unless

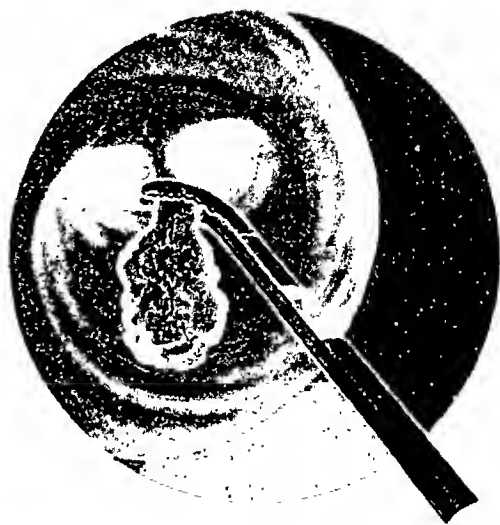


FIG. 7. Application of special clamp to pedicle of adenoma.

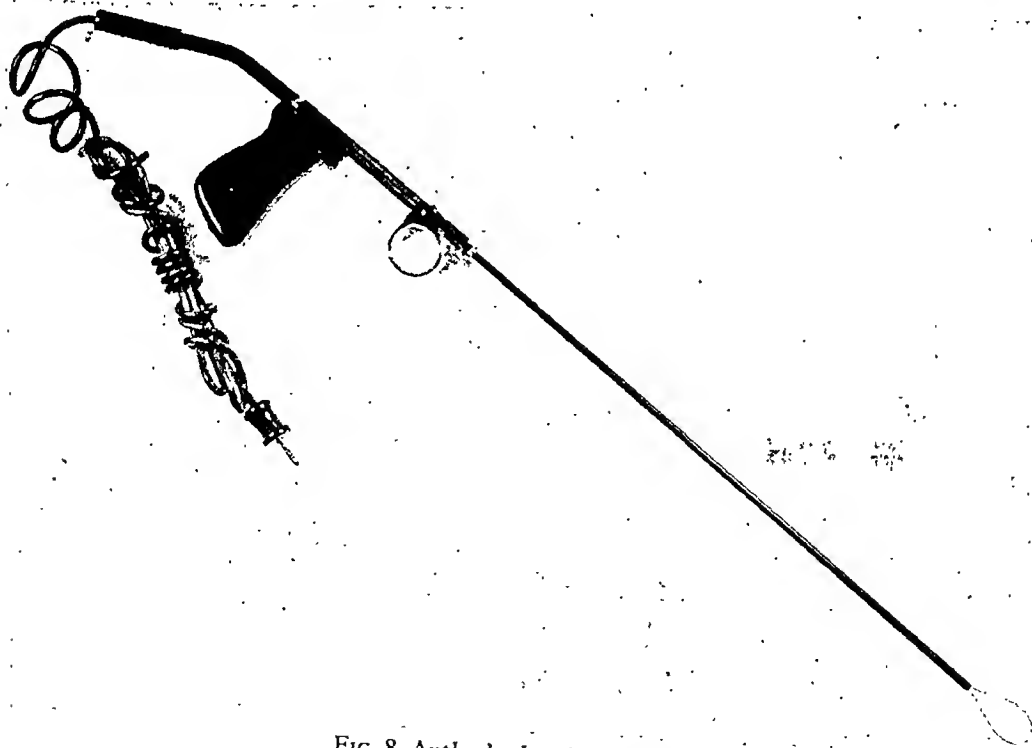


FIG. 8. Author's electric wire snare.

secondary infection or ulceration had occurred, no significant inflammation was found in the polyps or supporting tissues. (Figs. 2 and 3.)

When pronounced dedifferentiation was present, the lesion was considered an early, pre-invasive, malignant transformation of an adenomatous polyp. (Figs. 2 and 4.) This reversion to the more immature or undifferentiated

type of cell may show atypism, large vesicular or hyperchromatic nuclei, frequent mitoses and excessive stratification.

*Comparative Material.* The foregoing study was compared and contrasted with a similar investigation conducted five years earlier with an equal number of patients but an older average age of approximately fifty years. These



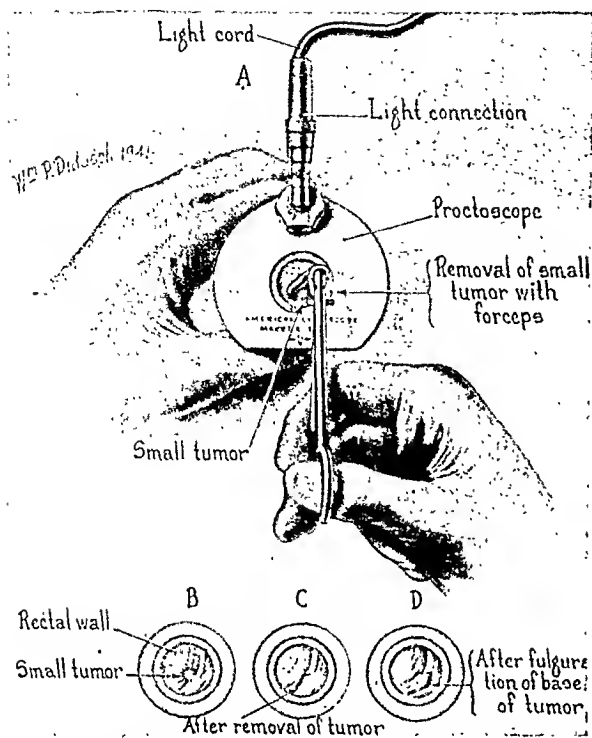


FIG. 9. Removal of small adenoma with angulated cold biopsy forceps. (Courtesy of *Ann. Surg.*, J. B. Lippincott Co.)

patients presented themselves because of intestinal symptoms, primarily bleeding from the rectum. In the latter group of patients sigmoidoscopy yielded twenty-seven adenomatous polyps exclusive of mucosal excrescences. An additional 1 per cent of pedunculated polyps situated beyond the reach of the sigmoidoscope was elicited on roentgenography. Significantly, five of the grossly benign-appearing, pedunculated adenomas showed malignant foci in their bodies upon histologic examination. Two patients with benign sessile polyps which were situated in the ampulla postponed treatment. After a lapse of approximately three years adenocarcinoma was found in the previously benign lesions of these individuals.

**Comment.** If the excrescences of the glandular mucosa (regarded by some authors as tiny sessile adenomas) are excluded, the clinical significance of the finding of definite adenomas in asymptomatic individuals remains for consideration. In a study of 241 consecutive necropsied colons of individuals varying from newborn infants to adults ninety years of age, Atwater and Barger<sup>3</sup> noted an incidence of 69 per cent of polyps; no polyps had been observed by them until the fourth decade of life. These observations suggest the advisability of routine

sigmoidoscopy as part of a comprehensive, general, physical examination, particularly in the older age group. This relatively simple examination will elicit approximately 50 per cent of benign and 75 per cent of malignant lesions of the terminal portion of the colon.

The propensity of benign adenomatous polyps to undergo malignant transformation is again exemplified by the cases just cited. Atwater and Barger<sup>3</sup> regard benign polyps as "one stage in the pathogenesis of a carcinoma." Other authorities also regard benign adenomas as "precancerous" lesions.<sup>4-7</sup> Collier and Berry<sup>5</sup> stated unequivocally that colonic polyps "are always precancerous lesions with a high chance of becoming cancerous." Since it is grossly difficult to define and recognize the transition from adenoma to carcinoma, I set out to observe these lesions histologically by means of periodic biopsies, hoping to learn more about the genesis of colorectal carcinoma. However, as this investigation progressed I realized that such a clinical experiment has little chance of success primarily because patients would hardly cooperate in a long-range study. This was shown by the behavior of two of my intelligent patients: One disappeared from observation after one re-examination while the second patient developed cancerphobia, necessitating the immediate extirpation of the polyp under observation.

**Treatment.** Because colonic adenomas are believed to constitute precursors of malignancy, it has been my policy to advise the eradication of these lesions upon clinical discovery before cancerous transformation has a chance to develop.

Endoscopic fulguration was employed for the extirpation of the pedunculated and sessile adenomas that were situated within the reach of the sigmoidoscope. Growths situated below the peritoneal reflection were treated in the office or clinic while those located above the peritoneal reflection, or the large sessile adenomas, were preferably treated in the hospital.

The pedunculated polyp may or may not be grasped at its tip with a suitable forceps (Fig. 5) before a wire snare is applied to the pedicle about 0.5 cm. from the base. (Figs. 6 and 7.) After the electric activation of the wire loop of the snare, the stalk of the polyp is strangulated by pulling the wire loop slowly into the hollow of the shaft of the snare, thus electrically

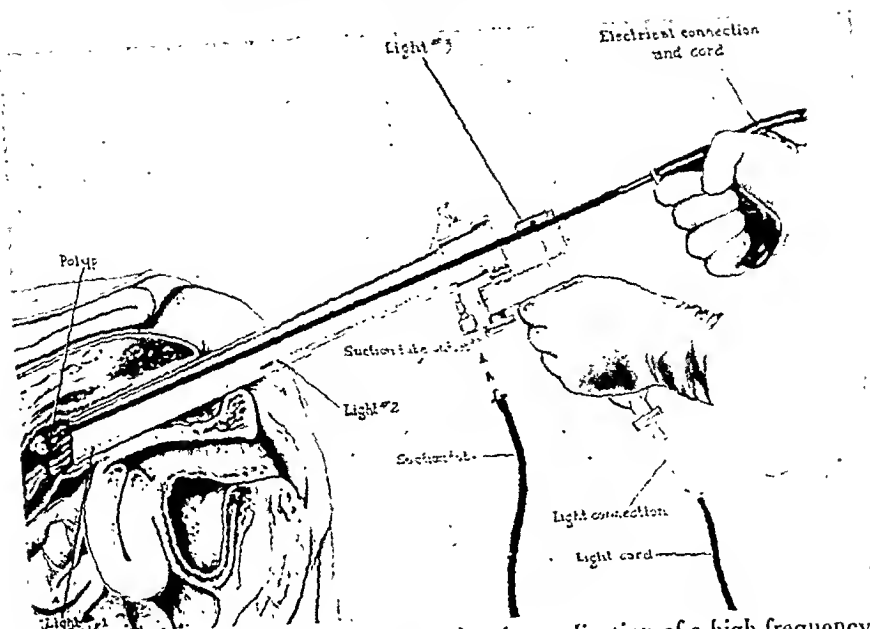


FIG. 10. Extirpation of sessile adenoma by the application of a high frequency current through a suitable electrode.

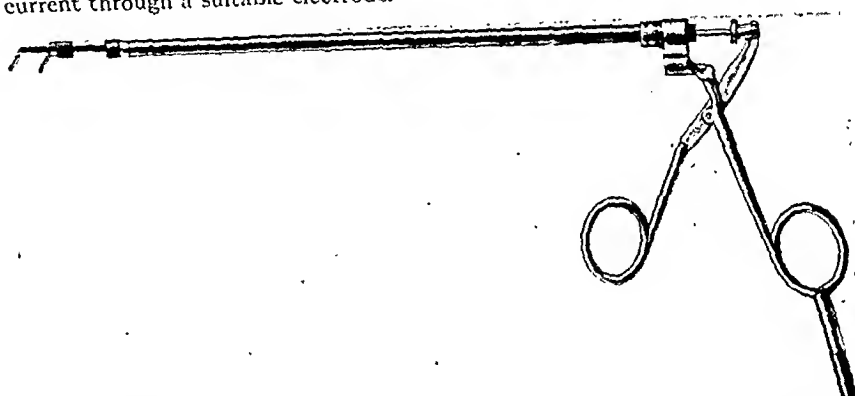


FIG. 11. Lateral view of author's double loop electric resector. (Courtesy of Surgery, C. V. Mosby Co.)

amputating the tumor cleanly and efficiently. In addition the raw base may be lightly coagulated with a monopolar current. When looping of the pedicle is technically impossible, the stalk near the base is clamped with a suitable clamp (Fig. 8) and electrically activated until the pedicle of the polyp is thoroughly charred. Subsequently the coagulated stalk with the polypoid mass sloughs off, thus producing a delayed but effective amputation of the polyp.

The small and sometimes medium-sized adenomas may be removed with a cold, angulated, biopsy forceps and followed by desiccation of the base with a monopolar current. (Fig. 9.) These lesions may also be destroyed *in situ* by application of a suitable electrode that is activated by a monopolar current, provided a preliminary biopsy had been secured. (Fig. 10.)

(Electrocoagulation *in situ* is, however, not utilized for the destruction of villous or papillary adenomas.)

Large sessile adenomas may be removed by utilizing a double loop resector with a bipolar current. (Fig. 11.) To remove the tumor the open loops are placed on the neoplasm, the desired cutting current is applied and the loops are closed. (Fig. 12.) These maneuvers are repeated until all the intraluminal projection of the neoplasm is resected. The base of the tumor may be coagulated (using a monopolar current) at the conclusion of the resection or at a later date. Bleeding is usually prevented by the hemostatic effect of the cutting current or it may easily be controlled by coagulation with the same instrument by substituting the coagulating for the cutting current.<sup>8</sup>

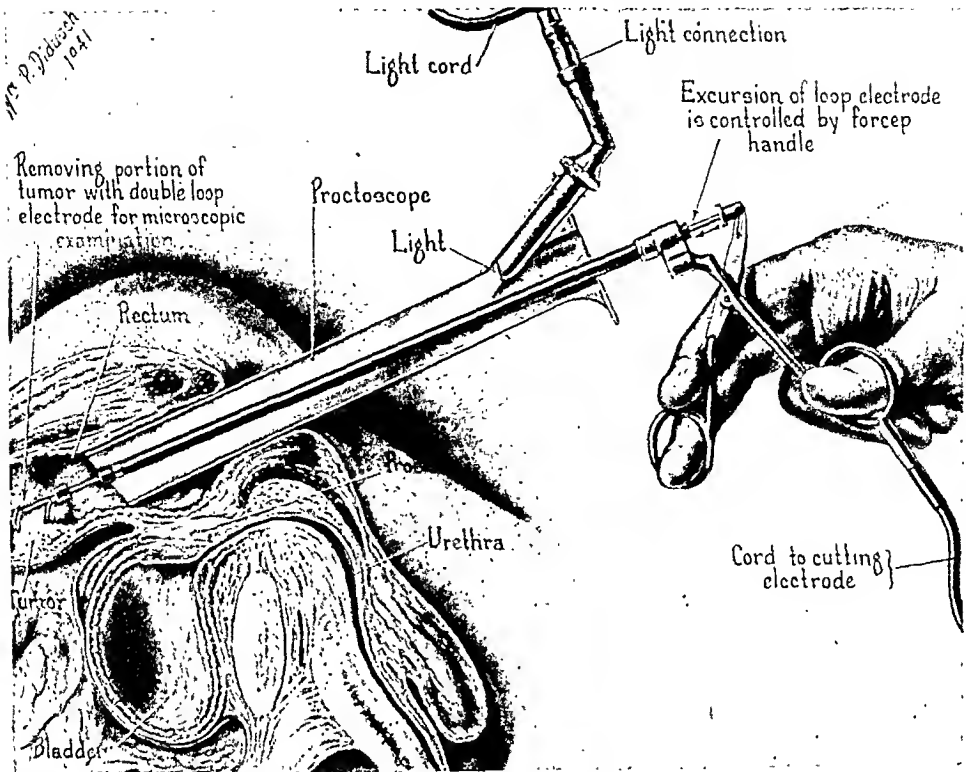


FIG. 12. Removal of sessile polyp with double loop resector. Note the travel of the proximal active loop. (Courtesy of Surgery, C. V. Mosby Co.)

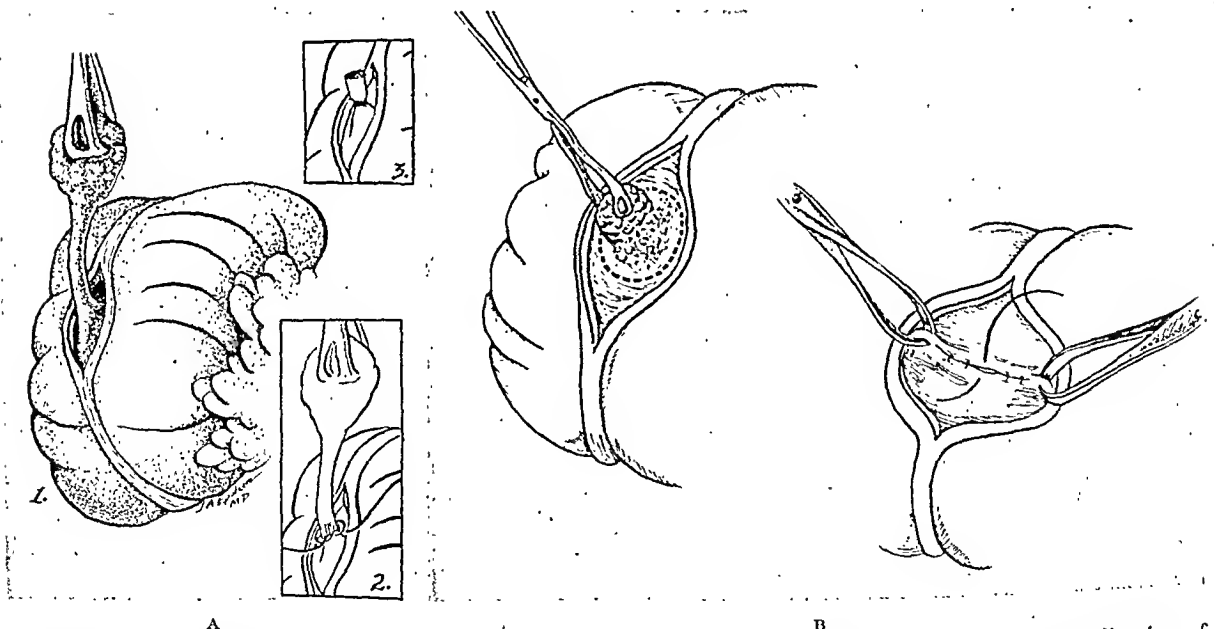


FIG. 13A, transcolonoscopic extirpation of pedunculated adenoma; (1) incision and delivery of polyp; (2) application of ligature to stalk and (3) severance of pedicle well above the area of ligature. B, wide resection of base mucosal and submucosal with removal of polyp.

The smoke produced by surgical diathermy may be removed by suction. Either suction tubes or hollow electrodes that are attached to a suction apparatus may be utilized for this purpose. I prefer to eliminate this smoke through a suction tube that is incorporated in the sigmoidoscope. (Fig. 10.)

Pedunculated polyps situated at the recto-sigmoid as well as those that are situated above the reach of the sigmoidoscope that cannot be safely extirpated instrumentally are removed through a transabdominal colotomy. The pedicle is crushed with an artery forceps above the base and tied. The stalk 1 cm. above the site of the ligature is then severed. (Fig. 13.) Colotomy with wide resection of mucosal base and submucosal structures may be employed for the removal of small and medium-sized sessile and short pedicled adenomas. (Fig. 13B.) (In some clinics the removed specimen is immediately examined microscopically to establish the presence or absence of invasion into the submucosa.) Segmental intestinal resection and end-to-end open anastomosis with or without a complementary proximal vent is usually utilized for the eradication of large sessile polyps.

**Recurrence.** Of twenty-seven patients with grossly sessile adenomatous polyps treated by surgical diathermy four showed small, benign, recurrent adenomas very close to or approximately at the site of previous fulguration within a period ranging between seven and sixteen months following the extirpation of the original adenomas. No recurrence has been observed in twenty-two patients with pedunculated adenomatous polyps. Of special interest is the absence of recurrence in four patients with pedunculated adenomas that contained focal carcinomatous transformation who have been followed and observed for over five years after the extirpation of the polyps by means of an electric snare. Three recent successful instances have been followed for less than one year.

#### SUMMARY AND CONCLUSIONS

Careful proctosigmoidoscopic examination of 386 individuals under forty-five years of age without intestinal symptoms revealed an incidence of about 2 per cent of adenomas exclusive of mucosal excrescences which are regarded as tiny adenomas by some authorities. A similar study of an equal number of somewhat older patients who complained of bleeding from the rectum revealed an incidence of about 7 per cent of adenomatous polyps. The advisability of sigmoidoscopy as part of a general physical examination is suggested.

While highly desirable, a long-range experimental study of adenomas by means of repeated sigmoidoscopic examinations and biopsies is apparently impractical.

The propensity of colonic adenomas to undergo malignant transformation makes the extirpation of these lesions mandatory.

The details of biopsy procurement and therapy are presented and illustrated.

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